AM / AP SERIES

Standby Power Supplies

AM 660 Series
AM 960 Series

Technical Manual

ALPHA TECHNOLOGIES

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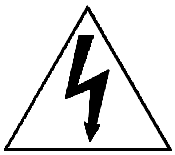
IMPORTANT SAFETY INSTRUCTIONS CONTAINED IN THIS MANUAL

CAUTION: TO REDUCE THE RISK OF ELECTRICAL SHOCK, AND ENSURE THE SAFE OPERATION OF THIS UNIT, THE FOLLOWING SYMBOLS HAVE BEEN PLACED THROUGHOUT THE MANUAL. WHERE THESE SYMBOLS APPEAR, SERVICING SHOULD BE PERFORMED ONLY BY QUALIFIED PERSONNEL.



DANGEROUS VOLTAGE

A DANGEROUS VOLTAGE EXISTS IN THIS AREA OF THE POWER SUPPLY. USE EXTREME CAUTION.

ATTENTION

IMPORTANT OPERATING INSTRUCTIONS. THIS PROCEDURE SHOULD BE PERFORMED ONLY BY QUALIFIED SERVICE PERSONNEL.

SAVE THESE INSTRUCTIONS

IMPORTANT TECHNICAL NOTE

CAUTION:

When operating the AP Series Standby Power Supply, a minimum load of at least 1.5 Amperes (approximately 10% of the output rating of the power supply) must be connected to the output. Failure to do so could damage the load or the unit's ferroresonant power transformer.

Damage caused by this condition will not be covered under warranty.

For further information, contact AlphaTechnologies or your nearest Alpha representative.

IMPORTANT SAFETY PRECAUTIONS

THE POWER SUPPLY SHOULD BE SERVICED ONLY BY QUALIFIED PERSONNEL.

THE POWER SUPPLY CONTAINS MORE THAN ONE LIVE CIRCUIT. EVEN THOUGH AC IS NOT PRESENT AT THE INPUT, IT MAY BE PRESENT AT THE OUTPUT.

WHEN USING AN EXTERNAL SERVICE DISCONNECT, VERIFY THAT IT IS EQUIPPED WITH A HIGH MAGNETIC TRIP BREAKER PROPERLY RATED (AMPERAGE) FOR USE WITH THE POWER SUPPLY.

THE USE OF IMMOBILIZED ELECTROLYTE-TYPE BATTERIES (SUCH AS GELLED OR OTHER VRLA - VALVE REGULATED LEAD ACID - BATTERIES) IS STRONGLY RECOMMENDED OVER LIQUID ELECTROLYTE-TYPES. WET CELL BATTERIES CAN LEAK OR SPILL, INCREASING THE RISK OF EXPOSURE TO CORROSIVE LIQUID ELECTROLYTIC ACID.

WHEN IN STORAGE, BATTERIES SHOULD BE CHARGED AT LEAST ONCE EVERY THREE MONTHS TO ENSURE OPTIMUM PERFORMANCE AND BATTERY LIFE.

WEAR EYE PROTECTION, SUCH AS SAFETY GLASSES OR A FACE SHIELD, WHENEVER WORKING WITH BATTERIES.

USE GLOVES WHEN HANDLING BATTERIES. BATTERY ELECTROLYTE IS ACIDIC AND MAY CAUSE BURNS.

NEVER SMOKE NEAR BATTERIES. SPARKS, FLAMES OR OTHER SOURCES OF IGNITION MAY CAUSE A BATTERY EXPLOSION.

ALWAYS CARRY A SUPPLY OF WATER, SUCH AS A WATER JUG, TO WASH THE EYES OR SKIN IN THE EVENT OF EXPOSURE TO BATTERY ELECTROLYTE.

USE PROPER LIFTING TECHNIQUES WHENEVER HANDLING THE ENCLOSURE, POWER MODULE OR BATTERIES. GROUP 31 SIZE BATTERIES, USED IN THE MAJORITY OF CABLE TELEVISION APPLICATIONS, CAN WEIGH AS MUCH AS 70 LBS.

USE A BUCKET TRUCK, OR SUITABLE SAFETY EQUIPMENT SUCH AS A SAFETY HARNESS AND CLIMBING SPIKES, WHEN SERVICING POLE INSTALLATIONS.

ALWAYS SWITCH THE POWER SUPPLY'S BATTERY CIRCUIT BREAKER TO OFF BEFORE DISCONNECTING BATTERY CABLES. THIS GREATLY REDUCES THE CHANCE OF SPARK AND POSSIBLE BATTERY EXPLOSION.

DO NOT ALLOW LIVE BATTERY WIRES TO CONTACT THE ENCLOSURE OR POWER SUPPLY CHASSIS. POSSIBLE EXPLOSION OR FIRE CAN OCCUR.

BEFORE PLACING A CURRENT LOAD ON THE BATTERIES, (SUCH AS WHEN SWITCHING THE POWER SUPPLY TO STANDBY), USE THE ENCLOSURE DOOR AS A SHIELD IN THE EVENT OF A BATTERY EXPLOSION.

INSPECT BATTERIES FOR SIGNS OF CRACKS, LEAKING OR SWELLING.

WHEN REPLACING BATTERIES, ALWAYS USE THOSE OF AN IDENTICAL TYPE. NEVER INSTALL OLD OR UNTESTED BATTERIES.

CHECK THE BATTERY'S DATE CODE. BATTERIES OLDER THAN SEVERAL YEARS SHOULD NOT BE USED.

AVOID THE USE OF UNINSULATED TOOLS OR OTHER CONDUCTIVE MATERIALS WHEN HANDLING BATTERIES OR WORKING INSIDE THE ENCLOSURE.

SPENT OR DAMAGED BATTERIES ARE CONSIDERED ENVIRONMENTALLY UNSAFE.
ALWAYS RECYCLE USED BATTERIES.

BATTERY CHARGING

ALWAYS REFER TO THE BATTERY MANUFACTURER'S RECOMMENDATION FOR SELECTING CORRECT FLOAT AND EQUALIZE CHARGE VOLTAGES. FAILURE TO DO SO COULD DAMAGE THE BATTERIES.

VERIFY THE POWER SUPPLY'S BATTERY CHARGER FLOAT AND EQUALIZE CHARGE VOLTAGES. REFER TO THE POWER SUPPLY'S OPERATION MANUAL.

BATTERIES ARE TEMPERATURE SENSITIVE. DURING EXTREMELY COLD CONDITIONS, A BATTERY'S CHARGE ACCEPTANCE IS REDUCED AND REQUIRES A HIGHER CHARGE VOLTAGE; DURING EXTREMELY HOT CONDITIONS, A BATTERY'S CHARGE ACCEPTANCE IS INCREASED AND REQUIRES A LOWER CHARGE VOLTAGE.

TO COMPENSATE FOR CHANGES IN TEMPERATURE, THE BATTERY CHARGER USED IN THE POWER SUPPLY IS TEMPERATURE COMPENSATING. FLOAT AND EQUALIZE CHARGE VOLTAGES WILL VARY DEPENDING UPON AMBIENT AIR TEMPERATURE.

IF BATTERIES APPEAR TO BE OVER OR UNDER-CHARGED, FIRST CHECK FOR DEFECTIVE BATTERIES AND THEN VERIFY CORRECT CHARGER VOLTAGE SETTINGS.

BATTERY PREVENTIVE MAINTENANCE

BATTERIES SHOULD BE INSPECTED EVERY THREE TO SIX MONTHS TO ENSURE OPTIMUM PERFORMANCE.

VISUALLY INSPECT BATTERIES FOR SIGNS OF CRACKS, LEAKS OR SWELLING.

CHECK BATTERY TERMINALS AND CONNECTING WIRES. BATTERY TERMINAL CONNECTORS SHOULD BE CLEANED PERIODICALLY AND RETIGHTENED TO APPROXIMATELY 50 INCH/LBS. SPRAY THE TERMINALS WITH AN APPROVED BATTERY TERMINAL COATING SUCH AS NCP-2.

CHECK BATTERY VOLTAGES UNDER LOAD. USE A LOAD TESTER IF AVAILABLE. DIFFERENCES BETWEEN ANY BATTERY IN THE SET SHOULD NOT BE GREATER THAN 0.3 VDC.

CHECK THE POWER SUPPLY'S BATTERY CHARGER VOLTAGES. REFER TO THE BATTERY MANUFACTURER'S RECOMMENDATION FOR CORRECT CHARGE VOLTAGES AND THE POWER SUPPLY'S OPERATION MANUAL FOR CORRESPONDING CHARGER SETTINGS.

NUMBER THE BATTERIES (1, 2, 3, ETC.) INSIDE OF THE ENCLOSURE FOR EASY IDENTIFICATION.

ESTABLISH AND MAINTAIN A BATTERY MAINTENANCE LOG.

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INTRODUCTION

1.1 The AM / AP Series Standby Power Supply

Alpha AP Series standby power supplies are designed for powering signal processing equipment in Cable Television and Broadband LAN distribution systems. The power supply, which consists of an AM Series power module and a pole or ground-mount enclosure, provides the critical load with current-limited, regulated AC power that is free from disturbances caused by spikes, surges, brownouts or blackouts. Backup power is achieved by a set of rechargeable, gelled electrolyte (no maintenance) batteries.

During LINE operation, AC power enters the module where it is converted to a "quasi" square wave and regulated (at the required output voltage). It is then passed onto the load via the SPI (Service Power Inserter) located inside the power supply enclosure. At the same time, power is directed to the battery charger to maintain a float charge to the batteries.

When the incoming AC line voltage drops significantly, or a utility power outage occurs, the AM Series power module automatically transfers to inverter (STANDBY) operation in order to maintain power to the load. During the transfer, energy contained in the module's ferroresonant transformer continues to supply power to the output. Depending upon the type of batteries used, and the loading on the power supply, backup power can continue for several hours. When utility line power returns, the AM Series power module waits momentarily for the utility voltage and frequency to stabilize and then initiates a smooth, in-phase transfer back to AC line power. Once the transfer is complete, the battery charger quickly recharges the batteries in preparation for the next utility power outage.

The AP Series standby power supply contains an impressive list of features including a front panel ammeter to measure the output current; an output fuse to protect against excessive short circuit currents; a battery circuit breaker to protect the DC circuit; a "LINE" indicator to verify AC input power from the utility; and a "STANDBY" indicator to show inverter operation, along with test and alarm status on units equipped with APM (Automatic Performance Monitor). Optional features can include an elapsed time meter to accumulate "total outage time;" and a TEST / RESET switch to allow a technician to control the module from the front panel. Serval varieties of interchangeable logic card upgrades facilitate power supply self-testing and status monitoring.

UL Listed and CSA Approved, the AP Series standby power supply is designed to be one of the most rugged, reliable, and versatile power supplies available. Alpha Technologies, recognized as an international market leader in the field of backup power, offers complete technical support and prompt, reliable service to ensure that your power supply continues to provide years of trouble-free operation.

1.2 Theory of Operation

The AM Series power module contains a ferroresonant transformer, resonant capacitor, dual-mode temperature-compensated battery charger, DC to AC converter (inverter), transfer isolation relay, main power board, and removable logic card.

1.2.1 AC (LINE) Operation

During AC line operation, utility power is fed into the primary winding of ferroresonant transformer and through the contacts of the transfer isolation relay. At the same time, power is fed to the auxiliary transformer which provides power for the control circuitry. A charger winding on transformer feeds the charger circuit which provides the charge voltages to the batteries. An AC capacitor forms the resonant circuit of the ferroresonant transformer which provides excellent noise and spike attenuation, short circuit current limiting, and output voltage regulation. The ferroresonant transformer produces a "quasi" square wave output which resembles a rounded square wave.

The logic circuit constantly monitors the incoming AC line. When there is a significant drop or a complete interruption of AC input power, the logic circuit automatically initiates inverter operation.

NOTE: WHEN MEASURING THE OUTPUT VOLTAGE OF FERRORESONANT TRANSFORMERS, USE ONLY A TRUE RMS AC VOLTMETER. NON-RMS READING METERS ARE CALIBRATED TO RESPOND TO PURE SINE WAVES AND WILL NOT PROVIDE AN ACCURATE READING WHEN MEASURING A "QUASI" SQUARE WAVE OUTPUT.

1.2.2 Inverter (STANDBY) Operation

When the incoming AC Line voltage drops significantly, or a complete power outage occurs, the control logic's line monitor activates STANDBY operation. The battery powered inverter comes on-line (in-phase with the failing AC line) as the isolation relay switches to prevent AC power from back-feeding to the utility. The transfer from utility to inverter operation takes place in less than 16 milliseconds. During the transfer period, the energy contained in the ferroresonant transformer continues to supply power to the load. The following changes occur: The transfer / isolation relay opens to disconnect the AC line from the primary winding of the ferroresonant transformer. The control logic drives the inverter transistors ON and OFF at line frequency. This switching action converts the DC battery current into AC in the inverter winding of the ferroresonant transformer which provides regulated power to the load. The control logic, which includes a circuit to protect the inverter transistors from over-current damage, monitors the condition of the batteries during inverter operation. Since a prolonged AC line outage would severely discharge the batteries, resulting in permanent damage, the control logic disables the inverter when the batteries drop to approximately 10.5 VDC / battery (31.5 VDC / set).

When AC line voltage returns, the power module transfers back to LINE operation after approximately 1 minute. This delay allows the AC line voltage and frequency to stabilize before the control logic phase-locks the inverter's output to the utility input. It then de-energizes the isolation relay, re-connects the AC line to the primary of the ferroresonant transformer and disconnects the batteries from the inverter. This results in a smooth, in-phase transfer back to utility power without interruption of service to the load. The battery charging circuit is then activated to recharge the batteries in preparation for the next utility power outage.

1.2 Theory of Operation, *continued*

1.2.3 Charger Operation

The AP Series power supply uses a dual-mode, temperature-compensated battery charger. During AC line operation, a charger winding on the ferroresonant transformer feeds the charger circuit which provides "FLOAT" and "EQUALIZE" charge voltages to the batteries. The circuit consists of a switching regulator, inductor and other associated components. The charger winding of the transformer produces an AC voltage that is rectified by diodes and filtered by an inductor. Regulation is provided by a PWM (Pulse Width Modulation) controller on the logic card which switches the transistors ON at the appropriate duty cycle. This produces a regulated DC battery charging voltage. The charge current passes through a resistor to provide current-limit sensing for the charging circuit. A fuse protects the circuit in the event of a charger malfunction or reversal of the battery leads. The charge current is determined by the acceptance level of the batteries, but limited to 10 Amps maximum. As the batteries approach full charge, the charger's current tapers off to normal float levels.

On units equipped with the SCB (Standard Control Board), the charger provides a FLOAT charge to the batteries for approximately 2 weeks. The voltage is then slightly increased to EQUALIZE for approximately 2.5 hours before switching back to float. Both float and equalize charge voltages are calculated according to the battery manufacturer's recommendations. A switch, located on top of the logic card, allows a technician to manually sequence the charger through its dual charging modes. On units equipped with APM (Automatic Performance Monitor), the module's front panel switch performs the same function. With the optional APM or RPM logic upgrade installed, after the charger has completed 3 cycles of float and equalize (similar to SCB), it automatically initiates a 30 minute self-test. This is done approximately every 52 days to ensure that the inverter and batteries are capable of supporting inverter operation. NOTE: APM and RPM cards released after 1989, provide switch selectable float and equalize charge voltage settings, plus a remote battery temperature sensor.

LEDs located on top of the logic card display the charging modes. The standard control board (SCB) contains one red LED. When the LED is OFF, the charger is in float mode; when it is ON, the charger is in equalize mode. On units equipped with the optional APM logic upgrade, lighted LEDs indicate: SELF-TEST (yellow), EQUALIZE (green), AC FAIL (red), and DC FAIL (red). When the EQUALIZE LED is OFF, the charger is in float mode.

1.3 SPECIFICATIONS

MODEL	AM660	AM660	AM660-14	AM660-14	AM660-14	AM660-14	AM660-14
CONFIGURATION	J5	-	-	E	E	P	P
INPUT							
Voltage (VAC)	100	120	120	220	240	220	240
Frequency (Hz)	50	60	60	50	50	60	60
Current Max. (A)[1]	11.8	11	11	6.1	5.7	6.1	5.7
Low AC Ref. (VAC)	80	95	95	182	182	182	182
OUTPUT							
Voltage (VAC)	60	60	60	60	60	60	60
Current Max. (A)	12	12	14	12	12	12	12
Power (VA)	720	720	840	720	720	720	720
BATTERIES							
Number	3	3	3	3	3	3	3
Voltage (VDC)	36	36	36	36	36	36	36
Backup Time (Hrs)*	4.0	4.0	3.7	4.0	4.0	4.0	4.0
WEIGHTS							
(lbs)	62	62	62	62	62	62	62
(kg)	28.0	28.0	28.0	28.0	28.0	28.0	28.0

MODEL	AM960	AM960	AM960	AM960	AM960	AM960	AM960
CONFIGURATION	J5	J6	-	E	E	P	P
INPUT							
Voltage (VAC)	100	100	120	220	240	220	240
Frequency (Hz)	50	60	60	50	50	60	60
Current Max. (A)[1]	12	12	12	6.5	6.0	6.5	6.0
Low AC Ref. (VAC)	80	80	95	182	182	182	182
OUTPUT							
Voltage (VAC)	60	60	60	60	60	60	60
Current Max. (A)	15	15	15	14	14	15	15
Power (VA)	900	900	900	840	840	900	900
BATTERIES							
Number	3	3	3	3	3	3	3
Voltage (VDC)	36	36	36	36	36	36	36
Backup Time (Hrs)*	3.1	3.1	3.1	3.7	3.7	3.1	3.1
WEIGHTS							
(lbs)	67	67	67	67	67	67	67
(kg)	30.5	30.5	30.5	30.5	30.5	30.5	30.5

[1] At nominal line voltage.

*****NOTE: Battery run times are subject to temperature, age and overall condition of batteries.

1.3 SPECIFICATIONS, *continued*

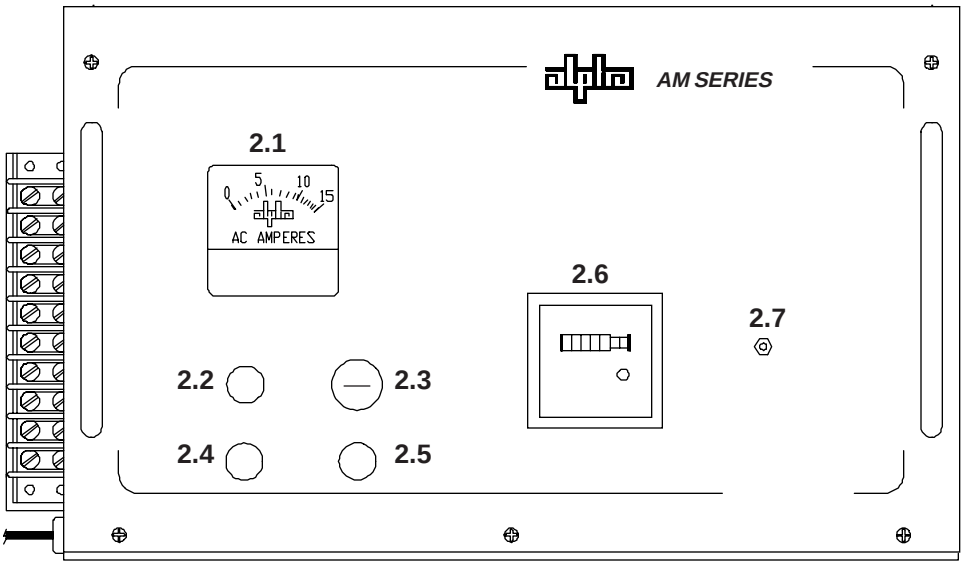
Regulation		
Input Voltage (VAC)		+/- 15%
Input Frequency (Hz)		+/- 3%
Output Voltage (VAC)		+/- 5%
Output Frequency (Hz)		+/- 1%
Inverter Frequency Stability		+/-0.05%
Output Current Limit		150% of maximum output rating
Transfer Time		less than 16 ms
Efficiency		90% typical @ rated load (LINE) 85% typical @ rated load (STANDBY)
Battery Type		Gelled electrolyte (or equiv) 12 VDC batteries
Battery Low Voltage Cutout		31.5 VDC (1.75 Volts per cell)
Battery Recharge Acceptance		37.5 VDC (typical)
Battery Float Charge Voltage		39.0 VDC to 44.4 VDC (selectable)* (2.16 VDC to 2.31 VDC per cell)
Battery Equalize Charge Voltage		39.0 VDC to 44.1 VDC (selectable)* (2.16 VDC to 2.46 VDC per cell)
Temperature Compensation		-0.05 Volts/^{0}F (-0.09 Volts/^{0}C)
Battery Charging Current		10 Amps maximum
Battery Recharge Time		12 hours typical (from low cutout) with 75 Ah batteries
Operating Temperature Range		-40^0 to +122^0 F (-40^0 to +50^0 C)
Finish		Gray, Powder Coat Paint
Dimensions	**Enclosures:**	
	PME	22" W x 24" H x 14" D (559mm x 610mm x 356mm)
	PWE	24" W x 24" H x 14" D (610mm x 610mm x 356mm)
	UPE	28" W x 35.3" H x 17" D (711mm x 889mm x 432mm)
	UPE/M	28" W x 45" H x 21.3" D (711mm x 1143mm x 540mm)
	Modules:	
	All AM Series	14.5" W x 10.0" H x 12.0" D (368mm x 254mm x 305mm)
Weights	**Enclosures:**	
	PME	34 lbs. (15.4 kg)
	PWE	47 lbs. (21.4 kg)
	UPE	66 lbs. (30.0 kg)
	UPE/M	124 lbs. (56.4 kg)

All specifications are at load @ 77^0 F (25^0 C)

***** When using APM, charge voltages should be user selected according to specific battery manufacturer's recommendations.

2. FRONT PANEL

THE AM SERIES FRONT PANEL



2.1 - Ammeter

2.2 - AC Output Fuse

2.3 - Battery Circuit Breaker

2.4 - LINE ON Lamp

2.5 - STANDBY Lamp

2.6 - Elapsed Time Meter (optional)

2.7 - Test/EQ Reset Switch (optional)

FRONT PANEL

2.1 Ammeter

The front panel ammeter displays output current flowing from the power module into the load. It is extremely useful in determining the status of the power supply during maintenance and trouble-shooting. When there is no load at the module's output, the ammeter reads zero. When the meter reads above the rated output of the module, such as 18 or 20 Amps, an overload or short circuit condition may exist in the load.

2.2 AC Output Fuse

The AC output fuse protects the load from excessive durations of short circuit current. If the front panel ammeter reads zero, indicating no output to the load, this fuse should be checked and replaced if necessary. ABC-15 Fuse: Alpha P/N (460-042-10) 15 Amp, 220 V Fast.

2.3 Battery Circuit Breaker

The front panel battery circuit breaker is used to disconnect the batteries from the module's DC circuit. When the breaker is OFF, the module will not be able to transfer to standby mode. The inverter is disabled and the battery charger is unable to charge the batteries. If a short circuit occurs in the DC circuitry, the breaker will trip.

2.4 LINE ON Lamp (Green)

The LINE ON lamp indicates the presence of utility AC and that the power supply is in its normal operating mode. For 60 Hz applications the lamp is green; for 50 Hz, amber.

2.5 STANDBY Lamp (Red)

The STANDBY lamp indicates that the power supply is operating on backup power from the batteries. When a brownout or utility outage occurs, the LINE ON lamp goes out and the STANDBY lamp lights to signal that the unit has transferred to inverter operation. On units equipped with an APM or RPM logic upgrade, the STANDBY lamp flashes to indicate when the power supply fails self-test and requires service. During the 30 minute self-test mode, the STANDBY lamp will come ON as well the LINE ON lamp, indicating the availability of utility AC (see section 7.2).

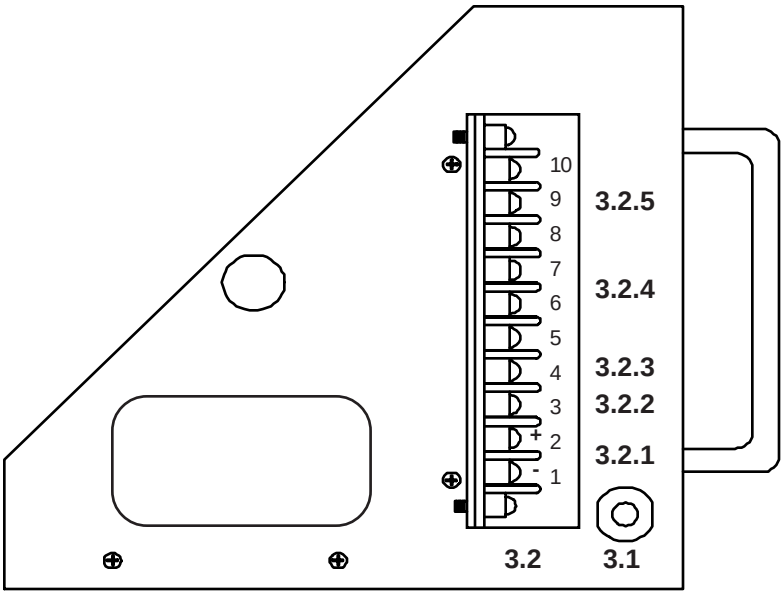
2.6 Elapsed Time Meter (optional)

The optional, Elapsed Time Meter is activated only during inverter operation. It is extremely useful for tracking battery use and displays elapsed time in hours. The clock, accurate to 0.01 hours, accumulates the total amount of time that the power module has been in standby mode.

2.7 Test/EQ Reset Switch (optional)

The front panel Test/EQ Reset switch is standard on all AM Series power modules equipped with APM or RPM logic upgrades. It duplicates the switch located on the logic card and is used to manually cycle the power module through charging modes (float and equalize), into self-test mode, and to reset alarms. If a fault is detected during the APM self-test mode, the Test/EQ Reset switch resets the module’s flashing STANDBY lamp and the enclosure’s flashing LRI (Local / Remote Indicator).

THE AM SERIES SIDE PANEL



3.1 AC Power Cord

3.2 10-Pin Terminal Strip

3.2.1 Battery Connection (Pins 1 and 2)

3.2.2 AC Output Connection (Pins 3 and 4)

3.2.3 ACI (AC Indicator) Connection (Pins 3 and 4)

3.2.4 LRI (Local / Remote Indicator) Connection (Pins 6 and 7)

3.2.5 Remote Alarm Connection (Pins 8, 9 and 10)

SIDE PANEL

3.1 AC Power Cord

The module's AC power cord plugs directly into the enclosure's convenience outlet. Since the module does not have an ON/OFF switch, simply unplug the power cord or use the utility circuit breaker as the main switch. In situations where the module is to be completely powered down, first switch the battery breaker OFF, or remove the battery fuse. This will prevent the unit from going into standby (inverter) operation when utility AC is removed.

3.2 10-Pin Terminal Strip

The 10-pin terminal strip provides all input and output connections to the power module. For easy identification, polarity and pin locations are clearly marked. Screw terminals accommodate both straight blade and Phillips screwdrivers. In the majority of installations, the batteries and the AC output (pins 1 - 4, respectively) are the only connections made to the terminal strip. Pin 5, in most cases, is not used.

3.2.1 Battery Connection

The batteries connect to pins 1 and 2 on the module's 10-pin terminal strip. Always verify proper polarity before connecting the battery cables to the module. Polarity is clearly marked for easy identification. The blue cable connects to pin 1 (negative); the red cable connects to pin 2 (positive). If, for some reason, the cables have been interchanged at the batteries, the 10 Amp fuse located on the module's main board will open. NOTE: Whenever making or breaking battery connections at the terminal strip, make sure that the battery breaker on the module's front panel is first pulled out, or the fuse removed.

3.2.2 AC Output Connection

The SPI (Service Power Inserter) couples output power from the module to the cable plant and connects to pins 3 and 4 on the10-pin terminal strip. The wiring configuration is clearly marked for easy identification. The white wire connects to pin 3 (neutral); the black to pin 4 (hot).

3.2.3 ACI (AC Indicator) Connection

The optional, green AC Indicator, which is externally mounted on the enclosure, indicates the presence of output power from the module. It co-connects to pins 3 and 4 (60 VAC) on the10-pin terminal strip along with the Service Power Inserter. The yellow wire connects to pin 3 (neutral); the black to pin 4 (hot). The indicator remains ON as long as there is output power.

3.2.4 LRI (Local / Remote Indicator) Connection

The optional, red Local / Remote Indicator, used in conjunction with the APM and RPM logic upgrades, connects to pins 6 and 7 (28 VDC) on the module's 10-pin terminal strip. The wiring configuration is clearly marked for easy identification. The white wire connects to pin 6 (negative); the blue to pin 7 (positive).

3.2.5 Remote Alarm Connection

On units equipped with APM and RPM logic upgrades, dry "Form C" contacts are provided to accommodate systems requiring remote alarms. Pin 8 is configured "normally open" (contacts close when alarm is present). Pin 9 is configured as common. Pin 10 is configured "normally closed" (contacts open when alarm is present).

STANDARD FEATURES

AP Series Standby Power Supplies are available in the following packages:
AM 60V Series power module with standard control logic; Pole-mount enclosure (PME) complete with galvanized mounting brackets, Service Power Inserter (SPI), "High Magnetic" trip circuit breaker and duplex receptacle. Optional pole (PWE) and ground-mount (UPE and UPE/M) enclosures are available. Batteries are separate.

4.1 AP660 Standby Power Supply

AM660 Module (120 VAC, 60 Hz Input) - (60 VAC, 14 Amp, 840 VA Output)

AM660 E Module (220 or 240 VAC, 50 Hz Input) - (60 VAC, 10 Amp, 600 VA Output)

4.2 AP960 Standby Power Supply

AM960 Module (120 VAC, 60 Hz Input) - (60 VAC, 15 Amp, 900 VA Output)

AM960 E Module (220 or 240 VAC, 50 Hz Input) - (60 VAC, 12 Amp, 720 VA Output)

NOTE: All models listed utilize a 36 VDC battery system.

OPTIONAL FEATURES

The following options can be ordered factory installed or, in most instances, can be field retrofitted by qualified service personnel.

5.1 APM (Automatic Performance Monitor) with RTS

The APM, with Remote Battery Temperature Sensing, is a field replaceable logic card that plugs directly into the edge connector located behind the main power board. It contains the circuitry that monitors the incoming utility AC, charges the batteries and controls the inverter. The APM also contains a self-test feature that automatically tests the batteries and inverter once every 52 days. If a problem is detected during self-test, LEDs on top of the card indicate the circuit that failed the test. The APM uses a 24-pin connector located on the component side of the board to accommodate RPM (Remote Parallel Monitor) plug-in logic cards.

5.2 RPM (Remote Parallel Monitor)

The RPM is a field replaceable logic upgrade that plugs directly into the existing APM (Rev 8 or higher) logic cards. The Remote Parallel Monitor allows the AM Series power module to be configured for pre-existing status monitoring systems such as Scientific Atlanta "6585," Magnavox "6DSS," Jerrold "RSM," AM Communications "TMC-8061," Texscan "Vital Signs," and C-COR "Quick Alert."

5.3 LRI (Local / Remote Indicator)

A standard feature when used in conjunction with APM and RPM logic upgrades, the LRI lamp (red) is located on the outside of pole-mounted enclosures and duplicates the function of the power module's front panel STANDBY lamp. During AC line operation, the lamp remains OFF. During inverter operation, the lamp remains ON. When a fault condition occurs during the APM self-test, an alarm circuit flashes the lamp to indicate that service is required. This acts as a simple form of status monitoring by allowing the cable technician to check the status of the power supply without having to climb the pole and open the enclosure.

5.4 ACI (AC Indicator)

The ACI lamp (green for 60 HZ / amber for 50 Hz) indicates AC output from the power module during LINE and STANDBY operation. The lamp is located on the outside of pole-mounted enclosures, next to the LRI. As long as power is present at the module's output, the ACI lamp remains ON. As with the LRI, this acts as a simple form of status monitoring by allowing a technician to check the status of the power supply's output without having to climb the pole and open the enclosure.

5.5 ET (Elapsed Time Meter)

Used to record accumulated standby time, the ET is helpful for tracking battery use and overall utility outage time. The counter, which displays elapsed time in hours, is activated only during inverter operation. The Elapsed Time Meter must be specified at the time of order.

5.6 IC (Incident/Event Counter)

The Incident/Event Counter maintains an active record of standby events. Whenever the module's inverter is brought on-line, the analog counter records the event, making it useful for determining battery use and counting utility outages. The IC easily retrofits into existing AM Series power modules.

5.7 LA-P (Lightning Arrestor)

The LA-P consists of a 350 Joule, Metal Oxide Varistor (MOV). It plugs directly into the enclosure's convenience outlet, eliminating the need for hard-wired MOVs. Enclosed in a plastic housing, the LA-P is used to provide additional protection from voltage spikes caused by lightning and other power disturbances. No wiring is necessary.

5.8 BCK - X (Battery Cable Kit)

Battery Cable Kits are heavy-duty wiring assemblies used to connect (3) gelled electrolyte, or equivalent batteries to the power module. All kits come with mounting hardware.

5.9 BCK-FX (Fused Battery Cable Kit)

Fused Battery Cable Kits are available for applications requiring additional battery circuit protection. Cables can be ordered with fuse ratings of 30 A (AP660) or 40 A (AP960). Always specify the application when ordering.

5.10 BMO (Battery Mat Option)

Used for a variety of applications, the rubber battery mat provides additional thermal isolation and battery shelf protection in PME enclosures.

5.11 BTO (Battery Tray Option)

Used mainly with less common wet cell applications, the BTO is designed to contain and prevent electrolyte from leaking onto the enclosure's shelf. It can also be used to provide additional thermal isolation from the power module. Battery trays are constructed of PVC and accommodate individual battery sizes up to Group 31. PME enclosures only.

5.12 APX (Adaptor for Plug-in Type Enclosures)

The APX contains a set of quick connects used to adapt AM power modules with spade lugs to Alpha enclosures equipped with plug-in type connectors.

5.13 MST (Module Slide Tray)

The MST is designed for use on PME and PWE pole-mount enclosures only and is compatible with all AM Series power modules. The MST's movable platform rides on a set of heavy-duty ball bearing slides to promote access to the power module during servicing. It is available factory installed or as a field retrofit kit.

5.14 DSE (Delete Service Entrance)

For installations requiring an externally-mounted service disconnect, the enclosure's internal service entrance, if equipped, can be removed. The DSE option, which must be specified at the time of order, eliminates the internal service entrance assembly. A Square D 15 Amp "HM" high magnetic trip circuit breaker (for use with the external service disconnect) and duplex outlet are included with this option. The DSE comes as standard equipment on most U.S. enclosures.

5.15 ISE (Internal Service Entrance)

For applications requiring an internal service disconnect to be located inside the enclosure, the ISE option features a Square D 15 Amp "HM" high magnetic trip circuit breaker, an agency approved service disconnect box and duplex outlet. The ISE comes as standard equipment on most Canadian enclosures.

5.16 STH (Storm Hoods)

Storm hoods are used on PME and PWE pole-mount enclosures to prevent snow from entering the enclosure during blizzard conditions. Specify the type of enclosure when ordering.

5.17 Additional Voltage Taps

AM Series power modules, with a nominal 60 VAC output, are available with 30 and 48 VAC taps located on the power transformer. Custom taps are available as special order items. Contact Alpha Technologies for further information and pricing.

5.18 APP60S (Service Power Supply)

The APP60S is a portable, non-standby power supply used to provide conditioned AC power to the load when the main power module is out of service. A front panel switch allows the APP60S to be set for 30 VAC or 60 VAC applications. Used in conjunction with the “Jones” connector and "ALT/ON" switch located on the enclosure's SPI (Service Power Inserter), power can be transferred from the main module to the APP60S without interrupting the load.

5.19 Batteries

Sealed, gelled electrolyte (no maintenance) batteries are recommended for use with AP Series standby power supplies. The majority of Cable Television and Broadband LAN operators prefer this type of battery due to its exceptional performance, safety record and service life. Batteries are available in ratings of 75Ah and 100Ah.

5.20 ABC-12 (Battery Charger)

The ABC-12 is designed for use with 12 volt specialty batteries such as gelled electrolyte products used in communications, UPS and standby applications. Selectable float or equalize charge modes optimize battery recharging. The charger is ideal for recharging batteries that have been in lengthy storage, plus batteries can be re-balanced using a parallel charge before use in series applications.

5.21 RTS (Remote Temperature Sensor)

The RTS connects the power module to the batteries to provide precise temperature compensation information. Standard with all current APM logic cards, the RTS can easily be retrofitted into existing Alpha power supplies equipped with SCB (Standard Control Board, Rev 4 and higher) and APM-TC (Automatic Performance Monitor with Temperatue Compensation, Rev 5 and higher).

5.22 Enclosures

AM Series standby power modules can be used in either pole or ground-mount installations. Pole-mount enclosures, PME (for cold climates) and PWE (for warm climates), are constructed of heavy-duty aluminum and come with two, galvanized steel mounting brackets. UPE and UPE/M ground-mount enclosures are constructed of heavy-duty aluminum and come with Galvanized (UPE/M only) steel doors. Alpha enclosures are vented to promote natural convection cooling and prolong battery life.

Alpha enclosures contain separate compartments for the batteries and power module. The battery compartment accommodates (3) Group 31 gelled-electrolyte, no-maintenance batteries and is equipped with a battery slide tray (except PME) for easy access. The module compartment accommodates the power module, a 15 Amp "HM" circuit breaker assembly, duplex receptacle and SPI (Service Power Inserter). The AC power connection to the breaker assembly is made through a conduit knockout on the rear of the PWE enclosure or through the base of the PME, UPE and UPE/M. The cable connection is made directly to the SPI’s "VSF" coaxial fitting located on the rear of the PWE, or at the base of the PME, UPE and UPE/M. There is adequate space in the module compartment to accommodate a variety of power modules, indicator lamps, and components used for status monitoring.

5.23 PS Series (Pedestal Supports)

Alpha pedestal supports provide a quick, one-step solution for ground-mount enclosure installations. Constructed of pre-formed, high density polyethylene (HDPE), the pedestal support eliminates the need for costly concrete work. The large body design provides excellent "hand hole" working space, allowing room for cable bends, wire loops and grounding connections. Pedestal supports are available for use with Alpha UPE, UPE/M, PWV/PED, PED/M and PMD/PED ground-mount enclosures.

5.24 AC Series (Amp Clamp)

Alpha Technologies' Amp Clamps are designed to protect active and passive equipment (such as amplifiers and power inserters) from voltage surges and transients. Amp Clamps can be ordered as retrofit kits, or factory installed in the desired host hardware. A Product/ Serial Number label is included with each kit so that retrofitted equipment can be easily identified. The Amp Clamp circuit consists of two, rugged SCRs (silicon controlled rectifiers) connected in an inverse parallel configuration with a steady state current rating of 35 Amps and a one cycle (8 ms) pulse rating of 500 Amps. The SCRs are triggered into conduction whenever the Amp Clamp's bi-directional trigger diode senses the presence of voltage transients exceeding its 190 - 265 Volt peak breakover voltage (instantaneous clamping). The fast response trigger SIDACTOR gates the appropriate SCR ON in a nanosecond (or less) to shunt the surge current to ground, effectively protecting sensitive equipment from transient overvoltage conditions. The Amp Clamp is compatible with numerous host hardware including: C-COR PS-550-C power inserter, PS-900-C power inserter and T500 amplifiers (6 & 8 port); G.I./Jerrold SSP-PI power inserter, SSP-3 two-way splitter and SSP- (7, 9, 12, or 16) directional couplers; Lindsay LPI-100 and 1GHz LPI-100 power inserters; Magnavox 4-LPI, 5-LPI, 8-LPI, 49-LPI and 59-LPI power inserters; RCA PI-1 power inserter; RMS CA-5400 and UP-6400 power inserters, and CA-5402/RFI two-way splitter; Scientific Atlanta SAIF-RFI power inserter; Regal RPI-60 (blue) power inserter; and Antronix RPI-60 (green) power inserter. If your equipment is not listed, contact Alpha Technologies for availability.

5.25 Computer Aided Training (CD-ROM)

Computer Aided Training for power supply maintenance is available for either MAC® or IBM® (and compatible) formats on CD-ROM. Technicians can learn operation, installation and maintenance skills at their own pace before leaving the office, thus reducing overall maintenance time and standardizing maintenance practices. The program can be viewed using PowerPoint Viewer®, included with the CD-ROM.

5.26 Instructional Videotapes

Instructional videotapes are available for AP Series power supplies including Product Overview, Theory of Operation, Installation, and Maintenance. Each tape is available in either NTSC (VHS) or PAL formats and covers all aspects of the Alpha Standby Power Supply. Transcripts of each tape are available upon request.

"Alpha Technologies: Market Leader in Standby Power" (P/N 048-082-00) is a 20 minute presentation which highlights standby power products and ephasizes reliability, ease of operation and customer service.

"The Alpha Standby Power Supply" (P/N 048-070-00) is a 10 minute conceptual overview of the Alpha standby power supply. The tape covers the advantages and disadvantages of forward and reverse transfer systems and compares them to Alpha's approach to standby power.

"Installing the Alpha CATV Standby Power Supply" (P/N 026-006-B4) is a 20 minute, step-by-step, description of the installation process. The tape includes ground and pole-mount applications, start-up procedures and testing the unit.

"Power Supply Maintenance for AP and AM Series Power Products" (P/N 026-006-B2 [108-3]) is a 30 minute presentation that covers all aspects of AP Series standby power supply operation and recommended maintenance procedures.

INSTALLATION

To ensure operator safety:

1. Power supplies should be installed only by qualified personnel and in accordance with applicable electrical codes.
2. Use eye protection whenever working with batteries.
3. Use only sealed, lead-acid type batteries (gelled-electrolyte or equiv., 55 Ah min.)
4. Use a bucket truck, or suitable climbing equipment such as a safety harness and climbing spikes, whenever installing or servicing pole-mount installations.

6.1 Unpacking and Inspection

Carefully remove the power module and enclosure from their shipping containers. Make sure that the following items have been included:

1. AM Series Power Module (including APX and BCK-X battery cable kits).
2. PME Pole-mount enclosure (with two, galvanized mounting brackets, SPI service power inserter, 15 Amp "HM" trip circuit breaker assembly with duplex receptacle). PWE, UPE and UPE/M are optional enclosures. Batteries are shipped separately.
3. Operator's Manual.
4. Any other ordered options.

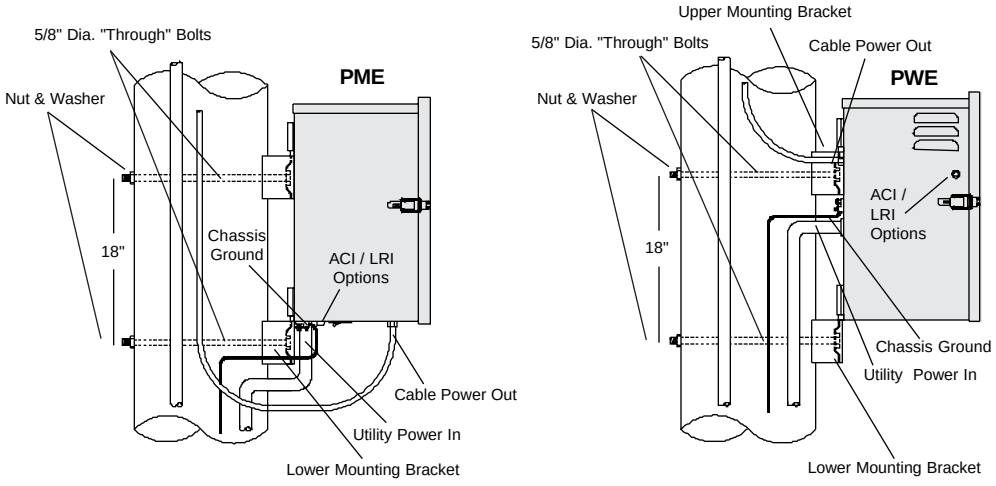
Inspect the contents. If items are damaged or missing, contact Alpha Technologies and the shipping company immediately. Most shipping companies have only a short claim period.

SAVE THE ORIGINAL SHIPPING CONTAINER.

In the event a unit needs to be returned for service, it should be packaged in its original shipping container. If the original container is not available, make sure the unit is packed with at least three inches of shock-absorbing material to prevent shipping damage. NOTE: Do not use popcorn-type material. Alpha Technologies is not responsible for damage caused by improper packaging on returned units.

READ THE OPERATOR'S MANUAL.

Become familiar with the power supply's front and side panel. Review the drawings and illustrations contained in the manual before proceeding. If you have questions regarding the safe installation or operation of this unit, contact Alpha Technologies or your nearest Alpha representative.



PME and PWE Pole-mount Enclosures (Wood Poles)

6.2 Pole-mount Enclosure Installation (PME and PWE)

PME and PWE enclosures are designed to be mounted on wooden poles; however, special brackets are available for concrete pole applications. Mounting bolts should go completely through the wooden pole and be secured from the back with a large washer and nut. The two galvanized mounting brackets mount between the enclosure and pole. Most codes require the base of the enclosure to be located a minimum height from the ground. Always verify height restrictions before proceeding. (Refer to the pole-mount drawings located at the back of the manual.)

NOTE: THE MAJORITY OF POLES ARE THE PROPERTY OF THE LOCAL UTILITY. BEFORE INSTALLING AN ENCLOSURE, THE LOCATION AND THE METHOD OF MOUNTING MUST BE APPROVED BY THE UTILITY.

Wood Pole Procedure: (see opposite page)

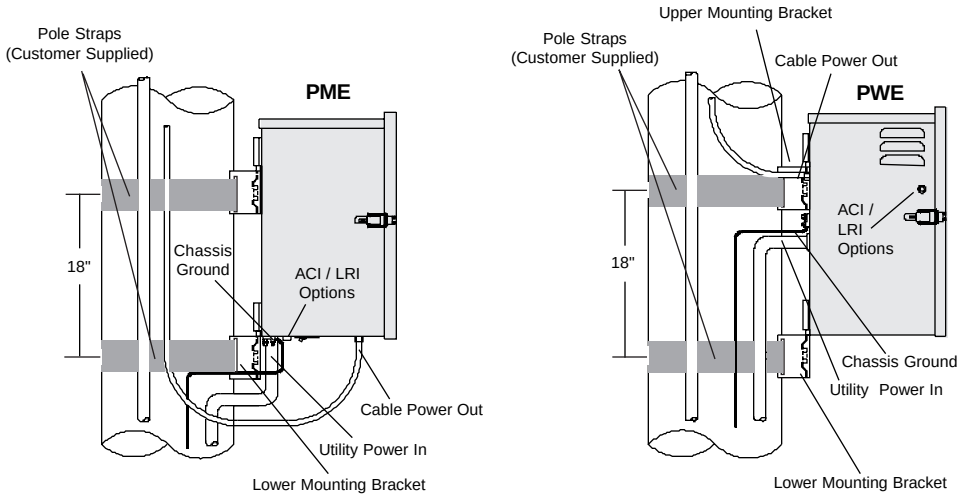
Materials required:	**Tools required:**
Two (2) 5/8" dia. machine bolts (UNC thread) SAE (Grade 5 or better), length to suit pole;	Auger or drill for boring 3/4" dia. holes in the wooden pole;
Two (2) 5/8" dia. zinc-plated flat washers;	Mallet or hammer;
Two (2) 5/8" dia. hex nuts (UNC thread).	Assorted sockets or wrenches.

1. Unpack the galvanized brackets and turn the enclosure face-down on a soft surface.
2. Slide one bracket up through the lower mounting strap on the rear of the enclosure. The bracket's flanges face away from the enclosure. Secure the lower mounting bracket using the 3/8" x 3/4" hex bolt (included).
3. Mark the position for the upper mounting bracket on the utility pole. Drill a 3/4" hole completely through the pole. Secure the bracket with a 5/8" machine bolt, washer and nut. Do not fully tighten the bolt at this time.
4. Position the enclosure on the upper mounting bracket. It may be necessary to slightly rock the enclosure and pull downward to properly seat it on the bracket. Center the enclosure on the pole.
5. Mark the hole for the lower mounting bracket. Lift the enclosure off of the top bracket and drill the lower hole. Spacing between the holes should be 18.0" on center.
6. Slide the enclosure back into place over the top bracket. Align the lower bracket with the hole and secure it with a 5/8" machine bolt, washer and nut. Tighten both brackets until the flanges seat into the wood.
7. The enclosure is now ready for the utility connection, power module and batteries.

Concrete / Steel Pole Procedure: (see below)

Materials required:	**Tools required:**
Two (2) Pole Straps (customer supplied) to fit pole. (straps must be stainless, galvanized or better)	Assorted sockets or wrenches.

1. Unpack the galvanized brackets and turn the enclosure face-down on a soft surface.
2. Slide one bracket up through the enclosure's lower mounting strap. The bracket's flanges should face away from the enclosure. Secure the lower mounting bracket using the 3/8" x 3/4" hex bolt included.
3. Position the upper mounting bracket on the pole and secure using a pole strap. Lift the enclosure onto the upper mounting bracket and pull downward to properly seat it. Center the enclosure on the pole.
4. Secure the lower mounting bracket on the pole using a pole strap.
5. The enclosure is now ready for the utility connection, power module and batteries.



PME and PWE Pole-mount Enclosures (Concrete and Steel Poles)

6.3 Ground-mount Enclosure Installation (UPE and UPE/M)

UPE and UPE/M enclosures are designed to bolt directly to a Pedestal Support or concrete pad. Four 1/2" holes are provided in the base of the enclosure to accommodate 3/8" Anchor or J-bolts. Secure the enclosure using a flat washer, lock washer and 3/8" nut at each mounting bolt. NOTE: Enclosures must be mounted flush with a smooth surface and not over-torqued to prevent damage. (Refer to the ground-mount drawings located at the back of the manual).

6.3.1 Pedestal Support Preparation

(Refer to the pedestal support drawings located at the back of the manual).

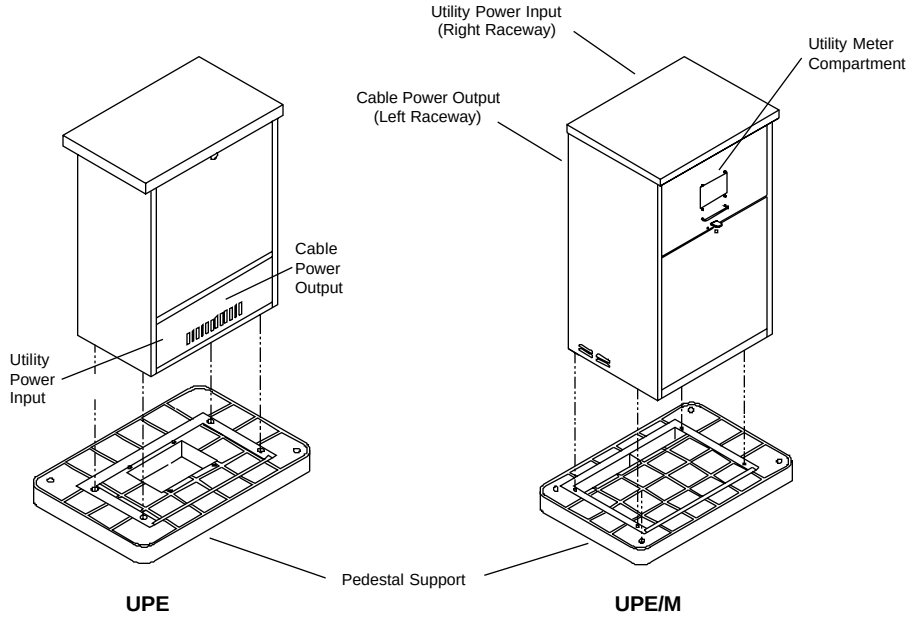
Pedestal supports, available from Alpha, provide a quick, one-step solution for ground-mount enclosure installations. Constructed of pre-formed, high density polyethylene, the pedestal support eliminates the need for costly concrete work. The large body design provides excellent "hand hole" working space, allowing room for cable bends, wire loops and grounding connections. Pedestal supports are available for use with Alpha UPE and UPE/M ground-mount enclosures. Installation is as easy as digging a hole to the appropriate depth to accommodate the base of the pedestal support and backfilling using a suitable material. See 1.3.2 below for recommended utility and cable TV conduit placements.

6.3.2 Concrete Pad Preparation

(Refer to the ground-mount drawings located at the back of the manual).

UPE - Four 3/8" J-bolts should be centered with the pad 24" (side to side) and 10" (front to back). From the front of the pad, service conduits should be placed with the utility entrance left of the center line; cable TV to the right. If required, an 8' dedicated ground rod should be placed near the utility conduit.

UPE/M - Four 3/8" J-bolts should be centered with the pad 24" (side to side) and 14" (front to back). Service conduits should enter the pad between the rear mounting studs and 6" to either side of the pad's center line. From the front of the pad, cable TV conduit should be placed on the left; utility on the right. If required, an 8' dedicated ground rod should be placed near the utility conduit.



UPE and UPE/M Ground-mount Enclosures

6.4 Connecting Utility Power

CAUTION: THE FOLLOWING SHOULD BE PERFORMED ONLY BY QUALIFIED SERVICE PERSONNEL AND IN COMPLIANCE WITH LOCAL ELECTRICAL CODES. CONNECTION TO UTILITY POWER MUST BE APPROVED BY THE LOCAL UTILITY BEFORE INSTALLING THE POWER SUPPLY.

NOTE: UL AND NEC REQUIRE THAT A SERVICE DISCONNECT SWITCH (UL LISTED) BE PROVIDED BY THE INSTALLER AND BE CONNECTED BETWEEN THE POWER SOURCE AND THE ALPHA POWER SUPPLY. CONNECTION TO THE POWER SUPPLY MUST INCLUDE AN APPROPRIATE SERVICE ENTRANCE WEATHER HEAD.

WIRING THE ENCLOSURE'S UTILITY SERVICE

Utility power enters the enclosure through a 1 1/8" opening at the bottom of PME, UPE and UPE/M, and the rear of PWE. The enclosure accepts a standard electrical fitting. The UPE is equipped with a service entrance mounted in the small compartment at the bottom of the enclosure. The PME and PWE are equipped with a circuit breaker assembly located in the enclosure's module compartment. UPE/M is equipped with a dedicated utility raceway.

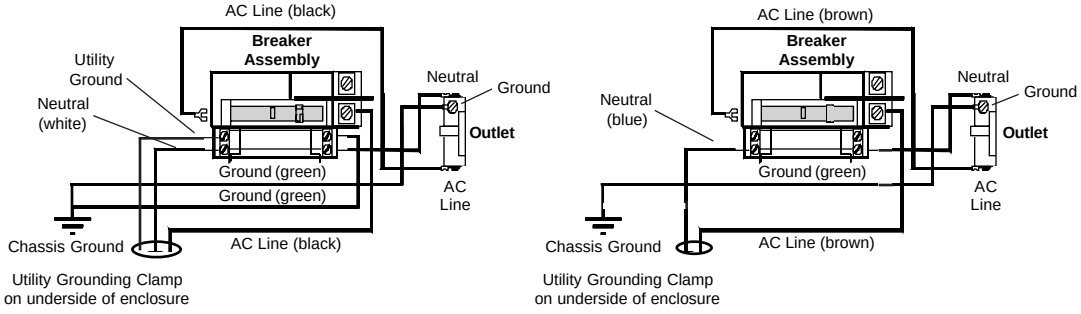
IMPORTANT NOTE: A "high-magnetic" trip breaker must be used in order to accommodate the high-inrush currents normally associated with the start-up of ferroresonant transformers (400 Amp, no-trip, first-half cycle). Do not replace this breaker with a conventional service entrance breaker. Alpha recommends Square D breakers because of increased reliability in this powering application.

High-magnetic Square D circuit breakers are available from Alpha Technologies, as well as a BBX option which is a UL Listed service entrance.

Description	Alpha Part No.	Square D
High Magnetic Trip Breaker (15A)	470-013-10	Q0115HM
Ext. Serv. Disconnect	020-085-10	Q02-4L70RB

AC Line (black) connects to the large terminal on the base of the breaker. Neutral (white) and Utility Ground (green) connect to the neutral bus bar located inside the breaker box assembly. An external grounding clamp is also provided on the outside of the enclosure to accommodate a dedicated ground rod. In most cases, this configuration is deemed suitable for service entrance use and usually does not require a separate, externally-located service disconnect (unless otherwise specified by local codes.)

If an external service disconnect is required, it is placed between the utility power connection and the standby power supply. It should be attached directly to the wooden utility pole using 1/4" x 2-1/4" steel wood screws. If a utility power meter is to be used, its mounting base should be secured in the same manner. Use a suitable conduit to interconnect the meter base, service disconnect, and power supply enclosure.



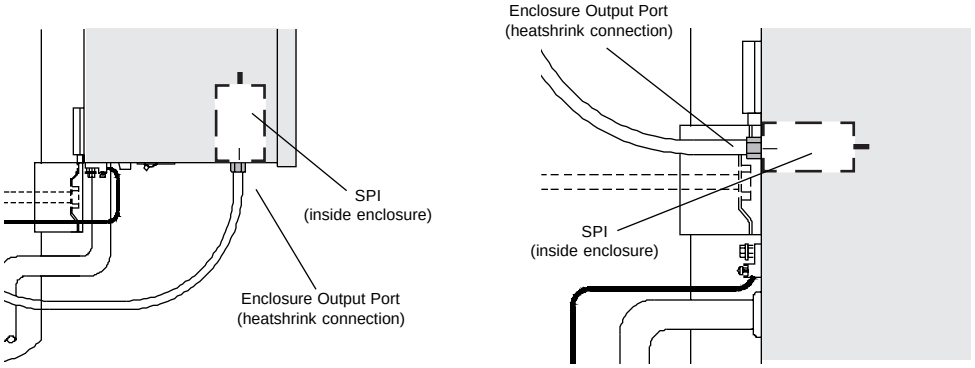
120 VAC (60 HZ) **220 or 240 VAC (50 HZ)**

Typical Circuit Breaker Assembly

6.5 Connecting the SPI (Service Power Inserter)

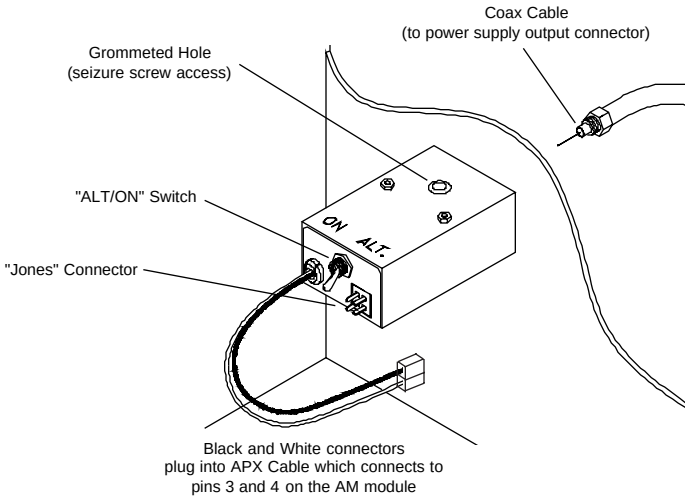
Procedure: (Refer to SPI drawing located at the back of the manual)

1. Prepare the incoming coaxial cable.
2. Remove the two screws from the Service Power Inserter and lift off the cover.
3. Loosen the seizure screw on the PCB, (located inside the SPI), to accommodate the center pin of the cable connector.
4. Screw the cable connector into the output port located on the rear panel of the PWE or UPE/M (or lower compartment of the PME or UPE) enclosure. Make sure that the center pin slides through the seizure screw assembly. Heat shrink the external connection.
5. Tighten the seizure screw on the SPI so that the center pin on the cable connector is firmly clamped. If a connection is left loose, arcing could result and possible damage to the connector or SPI could occur.
6. Replace the cover on the SPI. NOTE: Make sure that the screws securing the SPI's internal PCB to its chassis are tight; otherwise, loss of power, arcing, or possible damage can occur. During routine maintenance, the seizure screw assembly can be accessed through the grommeted hole without removing the SPI's cover.
7. Once the module has been installed in the enclosure, the SPI plugs into the APX cable which connects to pins 3 and 4 on the module's 10-pin terminal strip (See section 6.6).
8. Make sure that the "ALT/ON" switch, located on the Service Power Inserter, is in the "ON" position. When the switch is in the "ALT" position, the input is transferred to the SPI's "Jones" connector which is used with an alternative power source such as the Alpha APP60S Service Power Supply during module maintenance or replacement.



PME Enclosure **PWE Enclosure**

Cable Connection to SPI



SPI Service Power Inserter
(shown in PWE enclosure)

6.6 Battery Installation and Wiring

WHENEVER INSTALLING OR REPLACING BATTERIES, DO NOT ALLOW LIVE BATTERY WIRES TO CONTACT THE ENCLOSURE OR THE POWER MODULE CHASSIS. Insulate any exposed wire ends with electrical tape. Shorting battery wires could result in a fire or possible explosion. Make sure that the power module's battery circuit is deactivated by switching the battery breaker OFF, or removing the battery fuse.

WEAR EYE PROTECTION WHENEVER WORKING WITH BATTERIES.

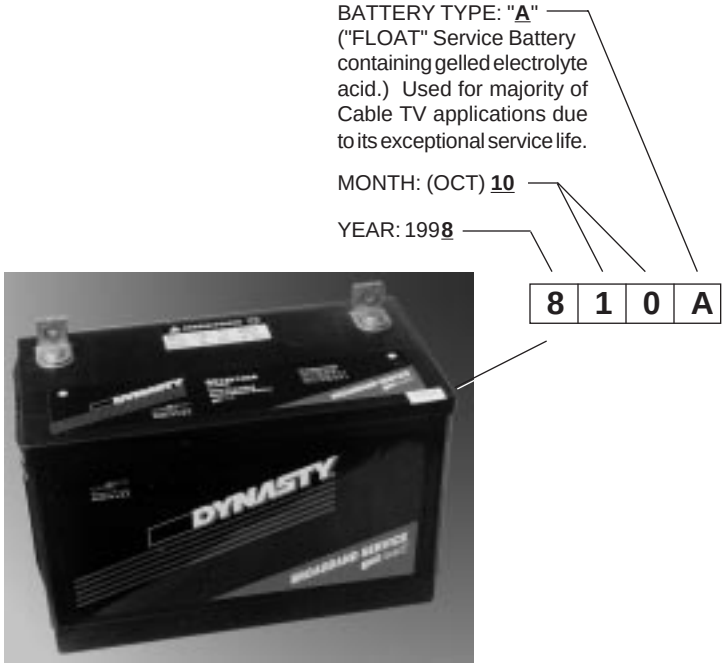
MAKE SURE THAT ALL BATTERY TERMINAL CONNECTIONS ARE TIGHT. Terminal connectors should be torqued to 75 inch-pounds at installation and then re-torqued to 50 inch-pounds during routine maintenance. Loose connections will cause the unit to operate improperly. Use an approved battery terminal coating such as NCP-2 to protect the terminals. If custom battery cables are made, they should be #6 AWG or larger and as short as practical. Battery terminals should be checked for corrosion and cleaned if necessary.

CHECK BATTERY POLARITY. Polarity identifications are clearly marked at the module's battery connector. A single battery connected backwards may go unnoticed until it is required to perform. In the event polarity becomes accidently reversed at the batteries, the battery circuit breaker will trip to protect the module.

IN ADDITION TO VOLTAGE CHECKS, ALWAYS INSPECT BATTERIES FOR SIGNS OF CRACKS, LEAKS OR SWELLING. If a battery has one or more defective (shorted or high impedance) cells, erratic operation or failure to provide standby power will result.

ALWAYS USE NEW BATTERIES WHEN FIRST INSTALLING A POWER SUPPLY. VERIFY THAT THEY ARE THE SAME TYPE OF BATTERY WITH AN IDENTICAL DATE CODE.

NEVER INSTALL OLD OR UNTESTED BATTERIES.
Whenever batteries have been in storage for more than 3 months, they should be recharged for (at least) 24 hours and checked under load prior to installation. Batteries with date codes older than 2 years should not be used unless thoroughly recharged and tested.


BATTERY TYPE: "A" ("FLOAT" Service Battery containing gelled electrolyte acid.) Used for majority of Cable TV applications due to its exceptional service life.
MONTH: (OCT) 10
YEAR: 1998
8 1 0 A
DYNASTY

Typical Battery Date Code Location and Identification

6.6 Battery Installation and Wiring, *continued*

Procedure: (Refer to the Battery Wiring drawing located at the back of the manual)

1. Place the batteries with the positive terminals forward on the enclosure's shelf or slide tray. Position the batteries with maximum ventilation space between them (+/- 1").
2. Interconnect the three batteries in series (negative to positive). The optional in-line fuse, if included, should be connected to the positive terminal on the right-hand battery.
3. Route the lugged ends of the cable through the grommeted holes in the enclosure's shelf and into the battery compartment. Connect the red cable (+) to the positive terminal of the left-hand battery. Connect the black cable (-) to the negative terminal of the right-hand battery. Terminal connectors should be torqued to approximately 75 inch/pounds at installation and then re-torqued to 50 inch/pounds during routine maintenance.
4. Use a voltmeter to verify polarity and DC voltage at the module's battery connector. **Caution:** Whenever making or breaking battery connections, never allow live battery cables to contact the chassis. If necessary, wrap the lugs with electrical tape to prevent arcing and temporarily disconnect one of the leads from the center battery.
5. Number the batteries 1 - 3, left to right, using labels or masking tape. Record each battery's number and date code in the power supply's maintenance log.
6. Uncoil the Remote Battery Temperature Sensor (RTS) cable. Route the sensor end of the cable into the battery compartment and attach it to the side of the center battery using a high-strength adhesive tape (see previous page for exact placement). In the event the sensor is disconnected, or fails, a secondary sensor located on the main board of the AM module provides temperature compensation based upon ambient temperature inside the enclosure.

Do not reset the battery breaker until the module is running on AC LINE power.

Battery terminal sizes and shapes vary depending upon battery type and manufacturer.

Battery Numbering and RTS Placement

Number the batteries inside the enclosure, 1 - 3 (left to right), for easy identification.

NOTE: The sensor should be placed approximately mid-way on the side of the center battery, 2/3rds of the way up from the base.

Attach the RTS Battery Temperature Sensor to either side of the center battery using high- strength adhesive tape.

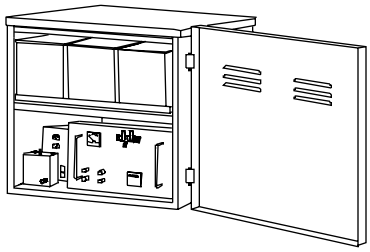
RTS Temperature Sensor Placement

6.7 Power Module Installation

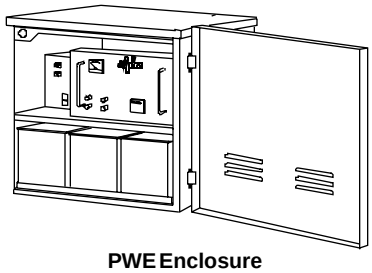
AM Series power modules are placed in the lower-right compartment of PME enclosures; the upper-right compartment of PWE, UPE and UPE/M enclosures. The enclosure's lid lifts and the door(s) can be removed. (Refer to the Module and Battery Placement drawings located at the back of the manual). NOTE: Enclosure components such as SPI and LRI accept plug-in type connectors. An APX cable is provided to accommodate the AM module's screw-in terminal block.

Procedure:

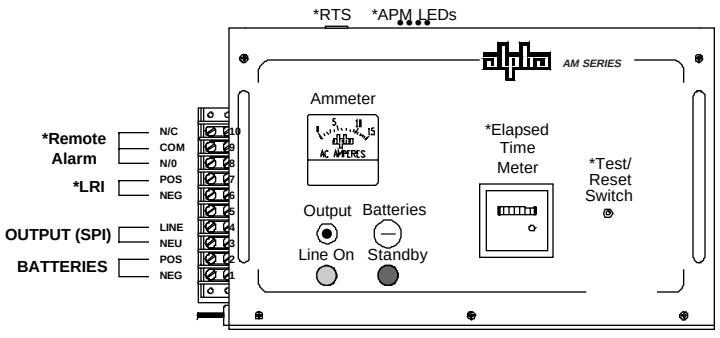
1. Slide the power module against the back wall of the enclosure (under the retaining brackets).
2. Use a retaining screw to secure the power module to the enclosure. The screw goes through the opening in the front lip of the module and into a hole in the enclosure's shelf.
3. Connect the wires from the SPI (Service Power Inserter) to the power module's 10-pin terminal strip: White to pin 3 (neutral); Black to pin 4 (60 VAC).
4. If an optional ACI (AC Indicator) is included, it should also be wired to the module's 10-pin terminal strip, along with the SPI: Yellow to pin 3 (neutral); Black to pin 4 (60 VAC).
5. Switch the battery circuit breaker, located on the module's front panel, OFF (or remove the battery fuse). This will prevent the inverter from starting when the batteries are first connected to the power module.
6. Connect the battery cables to pins 1 and 2 on the module's 10-pin terminal strip: Negative (blue) to pin 1; Positive (red) to pin 2. Polarity is clearly marked for easy identification. Route the cables through the grommeted hole in the enclosure's shelf and into the battery compartment.
7. If an optional LRI (Local and Remote Indicator) is included, it should be wired to the module's 10-pin terminal strip: Negative (white) to pin 6; Positive (blue) to pin 7.
8. If remote alarms are included in the installation: Pin 8 is configured "normally open" (contacts close when alarm is present); Pin 9 is configured as common; Pin 10 is configured "normally closed" (contacts open when alarm is present).



PME Enclosure



PWE Enclosure
(same placement for UPE and UPE/M)



* Indicates Options

AM Series Power Module

6.8 Logic Cards - Installation, Removal and Operation

THE POWER MODULE MUST BE COMPLETELY POWERED DOWN WHENEVER INSTALLING, REMOVING OR RESEATING A LOGIC CARD. IF NECESSARY, USE AN APP60S SERVICE POWER SUPPLY TO AVOID INTERRUPTION OF POWER TO THE LOAD.

Procedure:

1. Switch the module's front panel battery circuit breaker OFF, or remove the fuse.
2. Unplug the module's power cord or switch the AC input circuit breaker OFF.
3. Wait several minutes for the power module's capacitors to completely discharge.
4. Use the card ejectors to remove the logic card from the card guide. Handle the card only by the edges to avoid touching static sensitive parts.
5. Plug the new logic card into the card guide (component side facing away from the module's front panel). Make sure the card is properly seated before restoring power.

NOTE: IF POWER IS RESTORED WITH THE LOGIC CARD REMOVED, THE MODULE WILL CONTINUE TO OPERATE AS A NON-STANDBY POWER SUPPLY.

6.8.1 SCB (Standard Control Board)

AP Series power supplies come equipped with a field-replaceable, SCB standard control board that contains the circuitry to monitor incoming AC, charge the batteries and control the inverter. The board uses a dual-mode (float and equalize) temperature compensated battery charger to maintain the batteries. It can be equipped with an optional, RTS (Remote Temperature Sensor) which is attached to the side of the center battery to provide optimum battery temperature measurements. Battery charging voltages are factory set and do not require user recalibration unless the logic card has been repaired or has been tampered with. Custom settings for unique battery types, (other than gelled-electrolyte), must be specified at the time of order. The SCB can be manually sequenced through its two charging modes by pressing switch (S1) located on top of the logic card. When lighted, the board's LED indicates EQUalize charge. When the LED is OFF, the charger is providing a FLOAT charge to the batteries.

6.8.2 APM (Automatic Performance Monitor)

The APM is field-replaceable and contains the circuitry to monitor incoming AC, charge the batteries, control the inverter, and self-test the inverter and batteries. Unlike the SCB, the APM's dual-mode temperature compensated battery charge voltages (float and equalize) can be selected using rotory switches (S2) and (S3) which are located on top of the logic card. **NOTE:** Selecting the correct charging voltage is critical. The APM is pre-set for gelled electrolyte type batteries (switch S2 in position 5 to produce 40.5 volt float; switch S3 in position 3 to produce a 41.4 volt equalize charge). Always verify the two switch settings with the APM chart (section 6.8.2.2) when first installing a power supply, and again during routine maintenance. Custom settings for unique battery types (other than gelled-electrolyte) or special charging applications can be selected by changing the two rotory switch settings according to the APM chart (section 6.8.2.2). Always consult the battery manufacturer's recommendations before changing switch settings.

The APM can be manually sequenced through its various modes of operation by pressing the module's front panel TEST/Reset switch, or switch (S1) located on top of the logic card. When lighted, the APM's four LEDs (DS1 to DS4, respectively) indicate status and fault conditions: TEST (yellow), EQUalize (green), AC FAIL (red) and DC FAIL (red). When all four LEDs are OFF, the power supply is in its normal mode, providing a FLOAT charge to the batteries. The RTS (Remote Temperature Sensor), standard on the APM, connects directly to the top of the logic card and is routed to the battery compartment. The sensor is then attached to the side of the center battery to provide optimum battery temperature information (see illustration on page 22). In the event the RTS is disconnected or not used, a secondary sensor, located on the APM card, provides temperature compensation based upon the ambient temperature of the module compartment.

6.8.2.1 APM Battery Charging Selection

Rotary switches (S2) and (S3), located on top of the APM, are used to select FLOAT and EQUalize charge voltages. The FLOAT switch (S2) sets the charge voltage in 0.3 volts increments, starting at the calibration level 39.0 volts. The EQUalize switch (S3) **adds** 0.3 volts per setting **above** the value of the FLOAT switch setting.

The APM is preset for gelled electrolyte batteries (FLOAT 40.5 VDC; EQUALIZE 41.4 VDC). Always refer to the battery manufacturer's recommendations before selecting FLOAT and EQUalize switch settings. Failure to do so could result in battery damage or decreased service life.

Example:
Follow the chart below. In a typical 3-battery system (36 VDC), if the battery manufacturer calls for a FLOAT of 40.5 volts and an EQUALIZE charge of 41.4 volts, set the FLOAT switch (S2) to position 5 (40.5 volts) and the EQUALIZE switch (S3) to position 3 (0.9 volts).

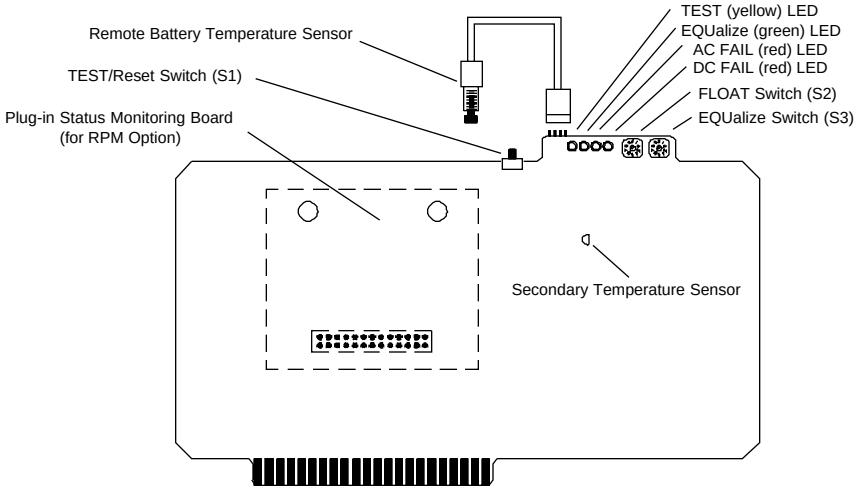
NOTE: The EQUALIZE value is added to the FLOAT voltage (i.e, 0.9 volts + 40.5 volts = 41.4 volts) to give the required EQUALIZE voltage.

6.8.2.2 APM Float and Equalize Chart

Values given for 36 volt systems calculated at 77°F (25°C).

Switch Setting	Calculated volts/cell	FLOAT (S2) volts/setting	EQUalize (S3) volts/setting
0	2.167	39.0	0.0
1	2.183	39.3	0.3
2	2.200	39.6	0.6
3	2.217	39.9	**0.9**
4	2.233	40.2	1.2
5	2.250	**40.5**	1.5
6	2.267	40.8	1.8
7	2.283	41.1	2.1
8	2.300	41.4	2.4
9	2.317	41.7	2.7

Alpha Technologies does not assume responsibility for batteries damaged by improper switch settings. Always consult the battery manufacturer for correct charging levels. If batteries appear to be over or under-charged, first check for defective batteries and then verify the correct charge voltage settings.



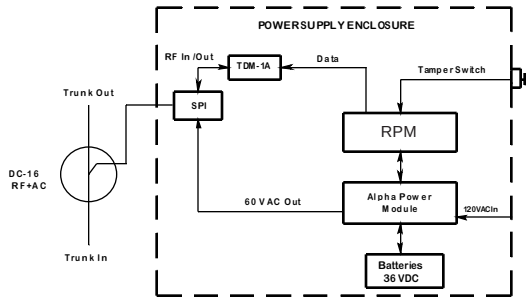
APM Logic Card

6.8.3 RPM (Remote Parallel Monitor)

The optional, RPM status monitoring logic upgrade plugs directly into connector J2 located on the component side of the APM logic card (Rev 8 or higher). NOTE: Power must first be removed before adding the RPM board (Refer to section 7.3 Power Module Shutdown). Status monitoring interfaces are listed below and identified according to their manufacturer, along with the associated parts. For additional installation information, refer to the RPM operator's manual.

RPM-T (Texscan Vital Signs "TDM-1A" and "RTDM-1A")

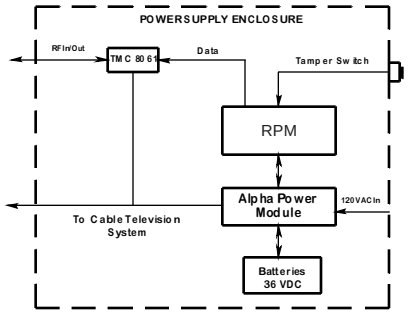
Designed for systems utilizing Texscan TDM-1A transponders. Transponders are internally mounted in Alpha power supply enclosures.



Contact Alpha Technologies or your nearest Alpha representative to order an RPM kit according to your specific enclosure. Please state enclosure type: PWE, PME, UPE, UPE/M or other.

RPM-AM (AM Communications "LANguard")

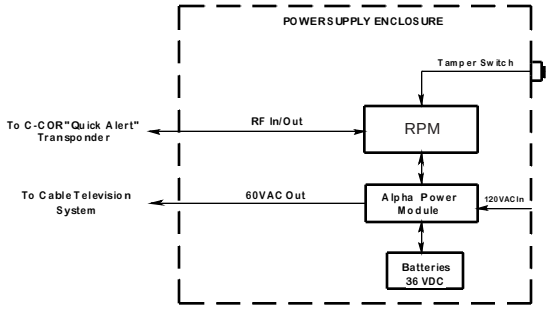
Designed for systems utilizing AM Communications TMC 8061 transponders. Transponders are internally mounted in Alpha power supply enclosures.



Contact Alpha Technologies or your nearest Alpha representative to order an RPM kit according to your specific enclosure. Please state enclosure type: PWE, PME, UPE, UPE/M or other.

RPM-C (C-COR "Quick Alert")

Designed for systems utilizing C-COR "Quick Alert" transponders. The transponder is externally mounted in its own enclosure.



Contact Alpha Technologies or your nearest Alpha representative to order an RPM kit according to your specific enclosure. Please state enclosure type: PWE, PME, UPE, UPE/M or other.

Order from C-COR:

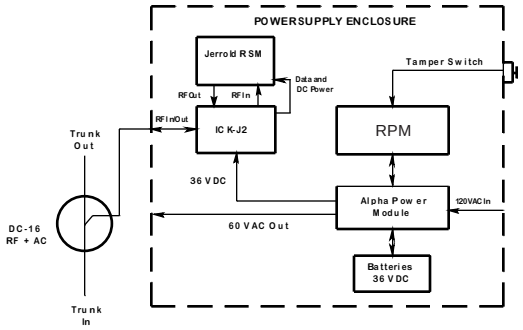
5' data cable	172960-01
10' data cable	172960-02
20' data cable	172960-03
40' data cable	172960-04

Configurations subject to change without notice.

6.8.3 RPM (Remote Parallel Monitor), *continued*

RPM-J (Jerrold "RSM")

Designed for systems utilizing Jerrold model “RSM” transponders. Transponders are internally mounted in Alpha power supply enclosures.

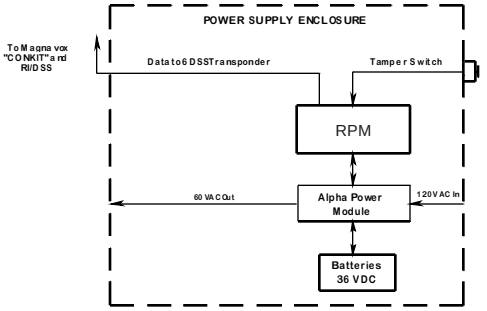


Contact Alpha Technologies or your nearest Alpha representative to order an RPM kit according to your specific enclosure. Please state enclosure type: PWE, PME, UPE, UPE/M or other.

Also order from Alpha:
ICK-J2 740-080-20-RPM

RPM-M (Magnavox "6-DSS")

Designed for systems utilizing the Magnavox 6-DSS Digital Sentry System. The transponder is externally mounted in its own enclosure.

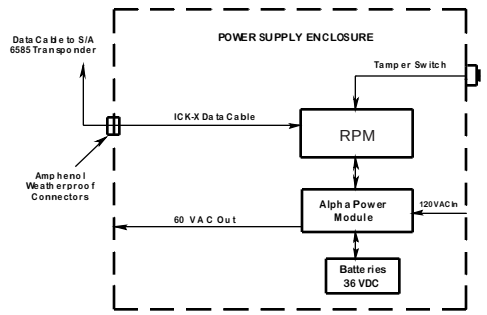


Contact Alpha Technologies or your nearest Alpha representative to order an RPM kit according to your specific enclosure. Please state enclosure type: PWE, PME, UPE, UPE/M or other.

Order from Magnavox:
CONKIT and RI/DSS
Data cable from USM to 6DSS

RPM-SA (Scientific Atlanta "6585")

Designed for systems utilizing Scientific Atlanta, Model 6585 transponders. The transponder is externally mounted in its own enclosure.



Contact Alpha Technologies or your nearest Alpha representative to order an RPM kit according to your specific enclosure. Please state enclosure type: PWE, PME, UPE, UPE/M or other.

Also order from Alpha:
ICK-X 740-050-20

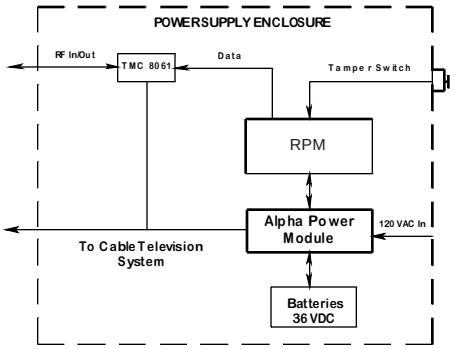
Order from Scientific Atlanta:
6585 data cable

Configurations subject to change without notice.

6.8.3 RPM (Remote Parallel Monitor), *continued*

RPM-LL (Magnavox "Lifeline")

Designed for systems utilizing the Magnavox Lifeline Status Monitoring System. The transponder is externally mounted in its own enclosure.

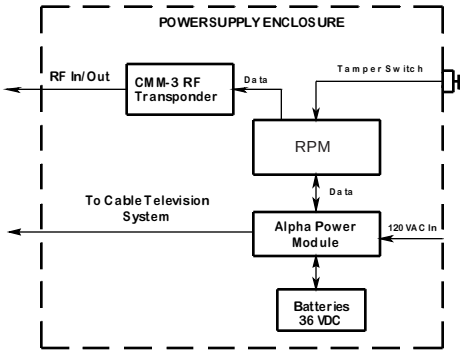


Contact Alpha Technologies or your nearest Alpha representative to order an RPM kit according to your specific enclosure. Please state enclosure type: PWE, PME, UPE, UPE/M or other.

Order from Magnavox:
CONKIT and RI/DSS
Data cable from USM to Lifeline

RPM-SEG (Superior Electronics "Cheetah")

Designed for systems utilizing Superior Electronics SEG transponders. The transponder is externally mounted in its own enclosure.



Contact Alpha Technologies or your nearest Alpha representative to order an RPM kit according to your specific enclosure. Please state enclosure type: PWE, PME, UPE, UPE/M or other.

Configurations subject to change without notice and may not be applicable under certain conditions.

OPERATION

7.1 Power Module Start-up and Testing

Once connections have been made to the power module, it should be tested for AC LINE and STANDBY operation before placing it into service. NOTE: The power module should always be started from utility AC (not batteries). This is because high inrush currents, associated with the start-up of ferroresonant transformers, could place unnecessary stress on the batteries.

7.1.1 AC Line Operation (LINE ON)

1. Plug the module's power cord into the enclosure's AC convenience outlet and switch the AC circuit breaker ON. The module's LINE ON lamp will light to indicate AC LINE operation: (Green for 60 Hz applications; Amber for 50 Hz applications).

2. Wait at least 1 minute and then reset the battery breaker on the front panel (or re-insert the fuse). If the red STANDBY lamp flashes, press the TEST/EQ RESET switch, located on top of the logic card (or the front panel, if equipped), once.

3. Use a true RMS voltmeter to verify AC output at pins 3 and 4 on the module's 10-pin terminal strip. If a non-RMS voltmeter is used, the output reading can vary by as much as 10% due to the "quasi" square wave output of the ferroresonant transformer.

4. Check the module's front panel ammeter to verify output current.

5. If the power module is equipped with an APM logic card, press the TEST/EQ RESET switch, located on the front panel, several times until the "TEST" LED lights. This will activate the self-test mode. If the logic card detects a problem in the battery or inverter circuit, it will flash the module's red STANDBY lamp. It will also light a LED (located on top of the logic card) to indicate the circuit ("DC" or "AC") that has failed self-test: DC indicates a battery-related problem; AC indicates an inverter-related problem.

6. Press the TEST/EQ RESET switch on the front panel once to cancel self-test and return the module to AC LINE operation. NOTE: The logic card contains an identical TEST/EQ RESET switch, located on top of the card, that performs the same function.

7.1.2 Inverter Operation (STANDBY)

1. With the power module operating from AC LINE power, indicated by the LINE ON lamp, unplug the module's AC power cord or switch the AC circuit breaker OFF. The LINE ON lamp will go OFF, indicating the loss of utility AC, and the STANDBY lamp will come ON to signal inverter operation.

2. Use a true RMS voltmeter to verify AC output at pins 3 and 4 on the module's 10-pin terminal strip.

3. Return the unit to AC LINE operation by plugging the AC power cord back into the receptacle, or switch the AC circuit breaker ON. It takes approximately 1 minute for the power module to complete its transfer back to utility power. This delay allows the utility voltage and frequency to stabilize for approximately 30 seconds before the module's phase-lock circuitry is activated. It then takes up to 30 seconds for the module to syncronize the inverter's waveform to the utility's. This ensures a smooth, in-phase transfer back to utility power. The LINE ON lamp will come ON to indicate that utility power is again available. During the transfer period, both the LINE ON and STANDBY lamps will remain ON. When the transfer is complete, the red STANDBY lamp will turn OFF.

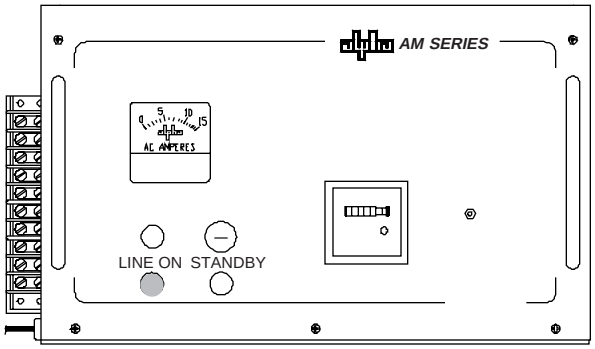
7.2 Identifying Modes of Operation

It is extremely important to be able to recognize the modes of operation indicated by the power module's front panel lamps: LINE ON (Green for 60 Hz applications; Amber for 50 Hz applications) and STANDBY (Red).

This is especially important when performing maintenance or trouble-shooting the power supply, Both lamps should be checked periodically for normal operation and replaced if necessary.

7.2.1 AC LINE OPERATION - Green Lamp ON (Red Lamp OFF):

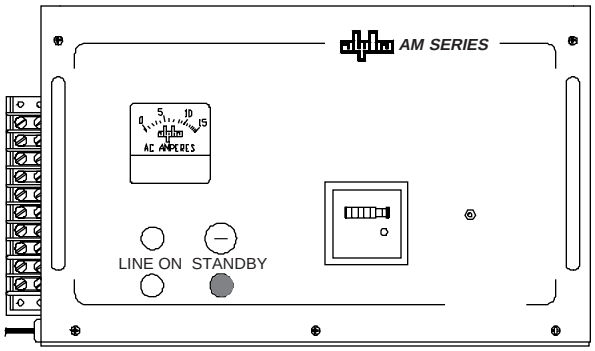
Indicates AC LINE operation with the power module running on utility power.



AC LINE OPERATION
(Green Lamp ON)

7.2.2 INVERTER OPERATION - Red Lamp ON (Green Lamp OFF):

Indicates inverter (STANDBY) operation using the battery backup. AC from the utility is unacceptably low or not available.

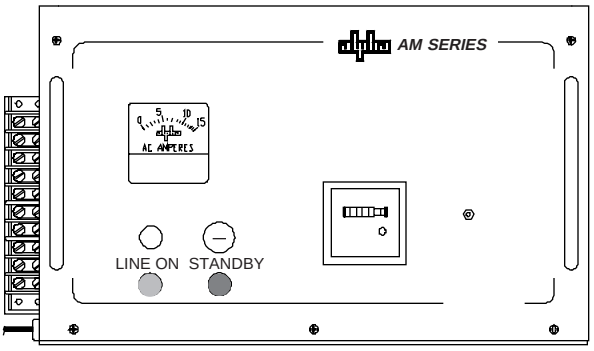


INVERTER (STANDBY) OPERATION
(Red Lamp ON)

7.2 Identifying Modes of Operation, *continued*

7.2.3 SELF-TEST / TRANSFER MODE - Green Lamp ON (Red Lamp ON):

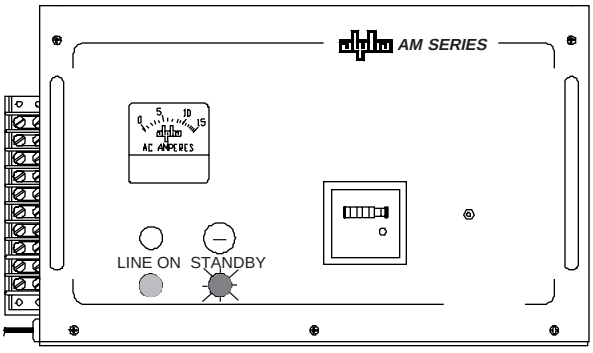
Indicates that the power supply is in either self-test or transfer mode. If the module is equipped with APM, check the LED on the logic card marked TEST. If the LED is ON, the module is in its 30 minute self-test mode. If the LED is OFF, or if the unit is equipped with an SCB logic card, the power module is preparing to transfer back to utility power after standby operation. The complete re-transfer takes approximately 1 minute to ensure that the utility voltage and frequency have stabilized, and to allow the power module to syncronize wave forms with the utility before transferring.



SELF-TEST (APM) or TRANSFER MODE
(Green and Red Lamps ON)

7.2.4 TEST FAIL - Green Lamp ON (Red Lamp FLASHING):

Indicates that the logic card has detected a problem with either the inverter or the batteries during self-test mode (only on units equipped with APM logic upgrade). Under this condition, maintenance is required. If an optional, external LRI lamp is installed on the enclosure, it will flash as well. As long as power is available from the utility, indicated by the LINE ON lamp, power will continue being supplied to the output; however, if the utility fails, the power supply will be unable to support inverter operation.



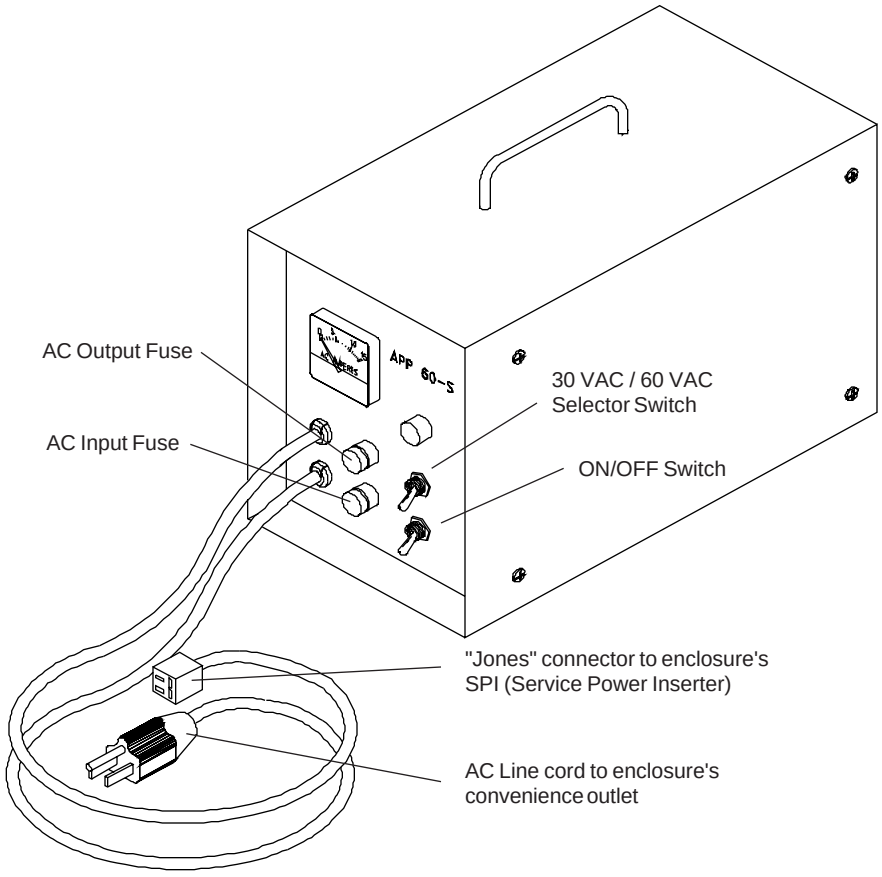
TEST FAIL (APM)
(Green Lamp ON with Red Lamp Flashing)

7.3 Power Module Shutdown

When a power module needs to be removed from service, an Alpha APP60-S Service Power Supply is recommended as an alternate non-standby power source to prevent interruption to the cable plant. NOTE: When powering down a module, always switch the battery breaker OFF before removing AC, otherwise the module will transfer into inverter operation.

Procedure

1. Plug the APP60-S "Jones" connector into the SPI (Service Power Inserter).
2. Plug the APP60-S power cord into the enclosure's convenience outlet. Switch the APP60-S ON. NOTE: Verify that the 30 / 60 VAC selector is in the desired position.
3. Toggle the switch on the SPI from "ON" to "ALT".
4. Switch the battery breaker on the front panel of the AM Series module OFF, or remove the fuse.
5. Unplug the AM Series module's power cord from the enclosure's convenience outlet.
6. Wait approximately 1 minute for the module's capacitors to fully discharge.
7. Disconnect the wires from the module's 10-pin terminal strip. Do not let the exposed battery cables come in contact with the chassis or enclosure.
8. Remove the hold-down screw and carefully slide the module out of the enclosure. CAUTION: The ferroresonant transformer generates heat and may cause burns if handled with bare hands.
9. Reverse this procedure, when re-installing a module. Always test the power module before toggling the switch on the SPI back from "ALT" to "ON".



APP60-S Service Power Supply

PREVENTIVE MAINTENANCE

Maintenance should be performed every three months. If the power module fails to perform a specific function, refer to the troubleshooting chart. By establishing a routine maintenance program and following the guidelines contained in this manual, the AP Series power supply will continue to provide years of trouble-free operation.

Care of the batteries should be the first step in any power supply maintenance program. In addition to voltage checks, visually inspect the batteries for signs of cracks, leaks or swelling. To aid in quick identification and tracing of voltages in the maintenance log, number the batteries inside the enclosure using labels or masking tape, etc. Because of a battery's chemical composition, it is temperature sensitive and susceptible to over and under-charging. Since batteries behave differently in the winter than they do in the summer, Alpha logic cards automatically compensate for changes in temperature by adjusting float and equalize charge voltages.

SAFETY PRECAUTIONS

THE POWER SUPPLY SHOULD BE SERVICED ONLY BY QUALIFIED PERSONNEL.

USE A BUCKET TRUCK, OR SUITABLE SAFETY EQUIPMENT (SAFETY HARNESS AND CLIMBING SPIKES), WHEN SERVICING POLE-MOUNT INSTALLATIONS.

USE HEAVY GLOVES WHEN HANDLING A POWER MODULE THAT HAS JUST BEEN TAKEN OUT OF SERVICE. THE FERRORESONANT TRANSFORMER GENERATES HEAT AND MAY CAUSE BURNS IF HANDLED WITH BARE HANDS.

NEVER ATTEMPT TO RECALIBRATE A LOGIC CARD IN THE FIELD, OTHER THAN SETTING APM (REV. 8 OR HIGHER) BATTERY CHARGER VOLTAGE SWITCHES (SECTION 6.8.2.1).

ALPHA TECHNOLOGIES IS NOT RESPONSIBLE FOR BATTERY DAMAGE DUE TO IMPROPER CHARGER SETTINGS. REFER TO SECTION 6.8 AND CONSULT THE BATTERY MANUFACTURER FOR CORRECT CHARGE VOLTAGE REQUIREMENTS.

WEAR EYE PROTECTION WHENEVER WORKING WITH BATTERIES.

ALWAYS SWITCH THE MODULE'S BATTERY BREAKER OFF, OR REMOVE THE FUSE, BEFORE DISCONNECTING BATTERY CABLES.

Procedure:

8.1 Check Battery Terminals and Connecting Wires

Check each battery terminal and connection. Make sure the posts are clean and the crimped connectors are tight. One major battery manufacturer suggests that terminal connectors be torqued to 75 inch/pounds at installation and then re-torqued to 50 inch/pounds during routine maintenance. If there is an "in-line" fuse in the battery cable, check the fuse holder and fuse. Make sure the terminals are properly greased with an approved battery terminal corrosion inhibitor such as NCP-2.

8.2 Check Battery Open Circuit Voltage

Switch the power module's front panel battery breaker to OFF, or remove the fuse. Disconnect the negative (blue) battery cable from pin 1 on the module's 10-pin terminal strip.

CAUTION: Do not let the exposed end of the battery cable contact the chassis or the enclosure. Measure the individual voltages across each battery. Differences greater than 0.3 VDC between any of the batteries may indicate a defective or marginal battery. Always use an identical type of battery for replacement.

8.3 Check Battery Voltage Under Load

If the batteries appear functional, reconnect the negative battery cable to pin 1 and switch the module's battery breaker ON, or re-install the fuse. **Caution: Weak or severely discharged batteries can explode when put under load. As an added safety precaution, place the enclosure's door between the technician and batteries before attempting inverter operation.** Turn off the AC circuit breaker, or pull the power cord, to initiate inverter operation. Measure individual battery voltages under load. There may be a rapid drop in voltage when the inverter first comes on, but it should stabilize within several minutes. The difference between any of the batteries should not be greater than 0.3 VDC. Replace defective or marginal batteries with an identical type of battery.

8.4 Check Battery Charger (FLOAT) Voltage

Reconnect the AC input and wait approximately 1 minute to allow the power module to return to AC LINE operation. The LINE ON indicator will be ON and the LED on top of the SCB logic card will be OFF. If the unit is equipped with an APM logic card, the four LEDs will be OFF. Switch the battery breaker on the front of the power module OFF, or remove the battery fuse. NOTE: If a LED is ON, press the TEST/EQ RESET switch, located on top of the logic card (or on the power module's front panel), once. Disconnect the negative (blue) battery cable from pin 1 on the module's 10-pin terminal strip. CAUTION: Do not let the exposed end of the cable contact the chassis or the enclosure. Switch the battery breaker ON, or re-install the fuse. Measure the DC voltage across pins 1 and 2 of the module's 10-pin terminal strip. Since the battery charger is temperature compensating, the charge voltage will vary depending upon the temperature measured at the batteries or inside the enclosure. The normal float charge for three gelled electrolyte batteries is approximately 40.5 VDC at 77^0 F (25^0 C). On hot days, the charge voltage will be several volts lower; On cold days, it will be higher. Record the float voltage in the power supply's maintenance log. If calibration is required, replace the logic card (SCB) and refer to section 6.8.

8.5 Check Battery Charger (EQUALIZE) Voltage

Press the TEST/EQ RESET switch, located on top of the logic card (or on the power module's front panel), once. On SCB logic cards, the single LED will light to indicate that the battery charger is in equalize mode. If the unit is equipped with an APM logic card, the green EQUalize LED will come ON. Measure the voltage across pins 1 and 2 of the module's 10-pin terminal strip. SCB and earlier APM versions will be approximately 1 VDC higher than the float voltage. For APM logic cards (Rev. 8 and higher), the equalize voltage will be in increments of 0.3 VDC (per switch setting) higher than float. Record the equalize voltage in the power supply's maintenance log. Switch the battery breaker OFF, or remove the fuse, and reconnect the negative battery cable to pin 1. Switch the battery breaker ON, or re-install the fuse. Always refer to the battery manufacturer for correct charging voltages. If calibration is required, replace the logic card and refer to section 6.8.

8.6 Check Output Voltage

Measure the AC output voltage across pins 3 and 4 on the module's 10-pin terminal strip. Use a true RMS digital voltmeter when taking voltages. The output voltage reading should fall between +/- 5% of the module's nameplate value (i.e., 57.0 VAC to 63.0 VAC for 60 VAC systems at nominal 120 VAC line input.) Record the voltage in the maintenance log.

8.7 Check Output Current

Check the module's output current. The front panel ammeter can be useful in determining the status of the output load. If there is no reading on the meter, check the AC output at pins 3 and 4; If no output voltage is present, check the AC output fuse on the front panel. Also make sure that the "ALT/ON" switch on the SPI (Service Power Inserter) is in the ON position. If the meter is pegged to the right, a short circuit or overload condition may exist in the plant.

8.8 APM Manual Self-test

On units equipped with APM logic cards (Automatic Performance Monitor), self-test can be manually activated to trouble-shoot the batteries and inverter. If a failure occurs during the test mode, either the “DC” or “AC” LED on the card will be activated to indicate the circuit that has failed (see below). The red STANDBY lamp on the front panel of the power module and external LRI option will flash to signal that maintenance is required. The APM self-test feature can be activated by pressing the TEST/EQ RESET switch on the front of the module (or on top of the card) several times until the “TEST” LED lights. To manually exit self-test and return the power module to normal operation, press the TEST/EQ RESET switch once.

8.8.1 “TEST” LED ON

The “TEST” LED indicates that the module is in its 30 minute self-test mode.

8.8.2 “DC” LED ON

If the “DC” LED is ON, it indicates that one or more of the batteries are unable to carry the load or that a connection in the battery circuit is malfunctioning. Check the battery breaker on the front of the power module to make sure that it is not tripped. Check the battery terminals and crimped connectors on the battery cable kit. Measure individual battery voltages and replace the suspect battery if necessary. Reactivate the self-test mode to verify that the problem has been corrected.

8.8.3 “AC” LED ON

If the “AC” LED is ON, it indicates that the inverter has failed to produce AC at the output. Verify AC output at pins 3 and 4 on the module's 10-pin terminal strip. If no voltage is present, check the AC output fuse on the front of the power module and replace it if necessary. If voltage is present, turn the power module OFF and reseat or replace the logic card. Reactivate the self-test mode to verify that the problem has been corrected. If the unit continues to fail self-test, the module needs to be serviced.

8.8.4 “EQU” LED ON

When the “EQU” LED is ON, it indicates that the battery charger is in its equalize mode. This increases the charge voltage to the batteries by approximately 1 volt. For APM logic cards (Rev. 8 and higher), the increase is determined by the EQUalize switch setting on top of the logic card. The equalize mode is activated once every two weeks and lasts approximately 2.5 hours. To manually exit this mode, press the TEST/EQ RESET switch once.

8.9 Logic Card Maintenance

CAUTION: NEVER ATTEMPT TO REMOVE OR RESEAT A LOGIC CARD WHILE THE POWER MODULE IS OPERATING. DAMAGE TO THE LOGIC CARD, INVERTER CIRCUITRY, OR CARD CONNECTORS MAY RESULT.

LOGIC CARD SERVICE AND CALIBRATION SHOULD BE PERFORMED ONLY BY A QUALIFIED TECHNICIAN OR AN ALPHA SERVICE CENTER.

Procedure:

1. Power down the module and remove the logic card. (Refer to section 6.8)
2. Inspect the card for signs of dust or corrosion. If necessary, clean with a soft, non-metallic brush or damp rag and allow the card to completely dry. Logic cards are static-sensitive and should be handled with care.
3. Clean the card edge connector with an alcohol-based cleaner (such as greaseless TV tuner cleaner). Also check the mating card edge connector inside the module and clean if necessary.
4. Carefully tighten any screws used for mounting components to the heatsink. Make sure that plug-in attachments such as APM and RPM options are firmly seated. Do not over-tighten semiconductor mounting hardware.
5. Re-install the logic card. Power up the module and test it for proper operation.

8.10 Internal Fuse Replacement

CAUTION: WHENEVER CHECKING OR REPLACING A FUSE ON THE MAIN POWER BOARD, MAKE SURE THAT THE POWER MODULE IS COMPLETELY POWERED DOWN BY SWITCHING THE BATTERY BREAKER OFF (OR REMOVING THE BATTERY FUSE) AND UNPLUGGING THE AC POWER CORD.

The AM Series Power Module contains two internal fuses (one 1 Amp and one 10 Amp). The fuses are clearly marked and located on top of the main power board, directly behind the ammeter.

1 Amp Fuse -
The 1 Amp fuse protects the DC circuit that powers the red STANDBY lamp on the module's front panel and the optionally-mounted, LRI lamp. If a short occurs in the lamp circuit, the fuse will open. This will not affect the overall operation of the power supply. The fuse should be replaced with an identical type fuse (1A 250V AGC1).

10 Amp Fuse -
The 10 Amp fuse, which is to the right of the 1 Amp fuse, protects the DC charger circuit and opens if battery polarity is reversed at pins 1 and 2 on the 10-pin terminal strip. Check this fuse if there is no charger voltage present at pins 1 and 2. An open fuse may also indicate a charger problem. The fuse should be replaced with an identical type fuse (10A 250V ABC10).

8.11 Additional Maintenance

In addition to normal preventive maintenance, enclosures and power modules should be cleaned periodically and checked for signs of battery acid corrosion, or buildups of dirt.

Procedure:

1. Power down the module by disconnecting the batteries and unplugging the AC power cord. Carefully remove the power module from the enclosure. Remove the batteries from the battery compartment.
2. Clean the module with a strong soapy solution using a brush to get into hard-to-reach areas. Use a soft rag to dry the module.
3. Clean the enclosure. Replace or re-fasten torn or loose bug screens. If there has been any leakage from the batteries, spray the battery compartment with an anti-corrosion agent, or apply a liberal sprinkling of baking soda to help neutralize the acid.
4. Tighten the mounting bolts that secure the enclosure to the pole.
5. Re-install the power module and batteries. Check all connections for tightness and test the unit for proper operation.

TROUBLE-SHOOTING AND REPAIR

The trouble-shooting guide is designed to display typical symptoms, causes and solutions, starting with the most obvious and working systematically through the unit. Alpha Technologies recommends that the power supply's maintenance log accompany units brought in for bench service to aid the technician in trouble-shooting the problem.

9.1 Repair Instructions

On units returned to Alpha Technologies for repair, a Return Material Authorization (RMA) should first be obtained from Alpha's Customer Service Department. The RMA should be clearly marked on the unit's original shipping container. If the original container is no longer available, the unit should be packed with at least 3 inches of shock-absorbent material. NOTE: Do not use popcorn type packing material. Returns should be prepaid and insured (COD and freight collect can not be accepted without prior approval). NOTE: It is recommended that any information pertaining to the nature of the power supply failure or problem, along with a copy of power supply's maintenance log, be included with the returned unit.

9.2 Parts Ordering Instructions

When ordering parts from Alpha Technologies, contact the Customer Service Department directly at (360) 647-2360; or (604) 430-1476 (Canada and International).

9.3 Common Parts for AP Series Standby Power Supplies

Alpha Part Number	Description
ASSEMBLIES	
020-019-20	Output Filter Assembly (SPI)
020-019-21	Output Filter Assembly (SPI) for PWV/PED (60")
020-019-22	Output Filter Assembly (SPI) for PWV (20")
740-018-20	AC Pilot Lamp Retrofit Kit for AM660
740-041-20	Remote Temperature Sensor (for APM rev 8)
740-048-20	12-12 RPM Cable (ICK)
740-083-20	LRI Lamp Socket w/ wires, lamp & lens
740-091-20	Bleeder Resistor w/ terminals
740-105-20	PWE-PME Power Box w/o LA
740-115-20	ACI, Complete Assembly (new)
740-120-20	Tamper Switch, PME (old style)
740-120-22	Tamper Switch and Harness, PWE (old style)
740-120-30	Jerrold Tamper Switch, PME (old style)
740-120-31	Jerrold Tamper Switch, UPE (old style)
740-120-32	Jerrold Tamper Switch, PWE (old style)
740-168-20	Surge Guard Kit
870-100-10	RPM Current Sense Cable
BATTERY CABLE KITS	
870-174-20	BCK Battery Cable Kit
870-174-21	BCK-F with 30A Fuse
870-174-22	BCK-F with 40A Fuse
870-174-30	BCK-FD Battery Cable Kit with Fast Disconnect
870-174-31	BCK-F/FD Battery Cable Kit with Fast Disconnect, 30A Fuse
870-174-32	BCK-F/FD Battery Cable Kit with Fast Disconnect, 40A Fuse
BREAKERS	
470-008-10	Klixon CA-12.5 Auto Reset Circuit Breaker, 12.5A
470-010-10	Klixon CA-15 Auto Reset Circuit Breaker, 15A
470-013-10	QO-115HM "High Magnetic" AC Circuit Breaker
470-017-10	QO-120HM "High Magnetic" AC Circuit Breaker
470-024-10	30A Circuit Breaker (Battery: All AM / AP Series)
470-027-11	40A Circuit Breaker (Battery: All AM / AP Series)
470-150-10	50A Circuit Breaker (Battery: All AM / AP Series)
523-002-10	Square D Breaker Mounting Bracket

9.3 Common Parts for AP Series Standby Power Supplies, *continued*

Alpha Part Number	Description
CAPACITORS	
190-013-10	0.001uF 500V Ceramic Disc Capacitor
190-015-10	0.01uF 500V Ceramic Disc Capacitor
194-005-10	0.1uF 100V Poly Film Capacitor
200-012-10	10uF 100V Electrolytic Capacitor
200-019-10	220uF 25V Electrolytic Capacitor
200-043-10	10,000uF 75V Electrolytic Capacitor
201-007-10	15uF 25V Tantalum Capacitor
210-010-10	18uF 660VAC “Oil” Capacitor (660)
210-011-10	20uF 660VAC “Oil” Capacitor (660-14 & 960)
CHASSIS PARTS	
590-271-P1	Left Side Panel (AM / AP Series)
590-272-P1	Right Side Panel (AM / AP Series)
590-278-A1	Card Guide Spacer (AM / AP Series)
CIRCUIT BOARDS	
700-020-20	AP661 Main Power Board, complete (specify model)
700-028-20	SCB Logic Card
700-027-20	APM Logic Card
700-034-20	Extender Card for Logic Board (Used for bench re-calibration)
700-035-20	PCB for Output Filter (SPI, w/o wires)
700-131-20	RPM Upgrade Plug-in Logic Card (specify amplifier mfg.)
CONNECTORS	
545-070-10	22-Pin PCB Socket
CRYSTALS	
410-004-10	CX Crystal, 30.750 KHz (Statek CX-1H)
410-007-10	4.91 MHz Crystal
DIODES	
301-001-10	1N4005 General Purpose Rectifier
301-003-10	MR752 General Purpose Rectifier
301-006-10	MR1122R General Purpose Rectifier
302-002-10	1N3890A Fast Recovery Rectifier
310-001-10	1N4148 General Purpose Switching Diode
313-002-10	1N4735A Zener Diode 6.2V 1W
FUSES	
460-008-10	1.0A Fuse (AGC-1)
460-037-10	10A Fuse (AGC-10)
460-039-10	12A Fuse (ABC-12)
460-041-10	15A Fuse (MDL-15)
460-042-10	15A Fuse (ABC-15)
460-053-10	30A Fuse (BAF-30)
460-054-10	40A Fuse (SC-40)
FUSE HOLDERS	
520-004-10	Fuse Holder, HKP (for ABC-15 fuse)
520-010-10	Fuse Holder, HPD (for FNW/BAF-30 fuse)
HARDWARE	
189-004-10	Battery Carrying Handles
640-017-10	Nylon Spacer (for MJ transistors)
641-019-10	Rubber Transformer Feet
643-003-10	Module Handles
647-008-10	Key for UPE Enclosure
651-007-10	Latching Clip, Small-UPE
651-008-10	Latching Clip, Large-PME
652-002-10	Plastic Card Guide (new type, 4.5 inches)
653-015-10	Rubber Boot for “Oil” Capacitors
654-003-10	Green Lens (AM Modules - Line)
654-004-10	Green Lens (ACI Option)
654-005-10	Red Lens (AM Modules - Standby)
654-006-10	Red Lens (LRI Option)
654-019-10	Green Lens, Lexan (New ACI Option)
655-001-10	Cover for Potter/Blumfield 491-013-10 Relay
655-002-10	Cover for 491-014-10 Guardian Relay

9.3 Common Parts for AP Series Standby Power Supplies, *continued*

Alpha Part Number	Description
IC SOCKETS	
521-004-10	14-Pin IC Socket
521-006-10	16-Pin IC Socket
INTEGRATED CIRCUITS	
360-002-10	7805 Voltage Regulator
360-201-10	TL494 Pulse Width Modulator
361-006-10	LM2904 Dual Op/Amp
361-202-10	LM2903 Dual Op/Amp
361-203-10	LM339N/LM239N Quad Comparator
366-001-10	4001B Quad 2-Input NOR Gate
366-003-10	4002B Dual 4-Input NOR Gate
366-004-10	4011B Quad 2-Input NAND Gate
366-006-10	4013 Dual Type D Flip Flop
366-007-10	4020B 14-Stage Ripple Carry Binary Counter
366-010-10	4043 NOR R/S Latch Quad Flip Flop
366-012-10	4049 Hex Inverting Buffer
366-016-10	4060B 14-Stage R.C. Counter, Divider, Oscillator
367-201-10	Programmed 8748 Microprocessor RPM Version
367-202-10	Programmed 8748 Microprocessor RSM Version
368-001-10	6402 UART
385-003-10	4N30 Optical Coupler
INDICATORS	
390-002-10	28VDC Lamp #PSB28 (AM Series - Standby)
390-004-10	36 VDC Lamp #1822 (LRI Option)
390-006-10	60V Lamp (New ACI Option)
390-007-10	60V Lamp #60A (ACI Option)
390-008-10	120VAC Lamp #PSB120 (AM Series - Line)
392-002-10	LED, Green (APM-8 Logic Card)
392-004-10	LED, MV55 (SCB Logic Card)
392-005-10	LED, Red (APM-8 Logic Card)
392-007-10	LED, Yellow (APM-8 Logic Card)
INSULATORS	
561-027-10	Insulator, Sil-Pad, TO-3 (for MJ transistors)
561-028-10	Insulator, Sil-Pad, DO-4 (for stud-mount diodes)
LAMP HOLDERS	
522-001-10	Lamp Holder (PSB Series)
522-002-10	Lamp Holder (ACI Option, Socket only)
522-003-10	Lamp Holder (LRI Option, Socket only)
522-005-10	Lamp Holder (New LRI Option)
LIGHTNING ARRESTOR	
020-049-20	350 Joule Plug-in MOV
MAGNETICS	
240-034-10	Ferroresonant Transformer (660)
240-036-10	Ferroresonant Transformer (960)
242-027-10	Control Transformer PCB Mount (All Models)
247-051-10	2.5mh 10A Choke
METERS	
400-007-10	0-20A AC Ammeter
405-401-10	Hourmeter, ET (meter only)

9.3 Common Parts for AP Series Standby Power Supplies, *continued*

Alpha Part Number	Description
RELAYS	
491-001-10	Relay, LRI
491-013-10	4PDT Contactor 24VDC, P&B
491-014-10	4PDT Contactor 24VDC, Guardian
RESISTORS	
114-001-10	1 ohm 1W 5% FP Resistor
114-011-10	68 ohm 1W 5% FP Resistor
114-015-10	220 ohm 1W 5% FP Resistor
115-003-10	15 ohm 2W 5% FP Resistor
121-512-10	180 ohm 5W 5% Resistor
SURGE DEVICES	
160-002-10	Varistor, V130LA10A (38 Joules)
170-002-10	Thermistor, SG100
740-092-20	Varistor Assembly (includes 160-002-10)
SWITCHES	
421-005-10	Toggle Switch, SPI
424-003-10	Push Switch (front panel AP Series, w/o wire)
TERMINAL BLOCKS	
535-039-10	Terminal Block, 10-Pin (AP Series)
TRANSISTORS	
320-002-10	2N4401 NPN Transistor
320-005-10	2N5550 NPN Transistor
321-002-10	TIP112 NPN Power Transistor
321-004-10	TIP31C NPN Power Transistor
321-011-10	MJ11032 NPN Power Transistor
322-003-10	2N3906 PNP Transistor
322-008-10	2N5400 PNP Transistor
323-003-10	TIP117 PNP Power Transistor

9.4 TROUBLE-SHOOTING GUIDE

SYMPTOM	PROBABLE CAUSE	REMEDY
No output to cable; No AC line power; Green “LINE ON” indicator OFF; Red “STANDBY” indicator OFF.	Utility power outage.	Use voltmeter to verify 120 VAC at receptacle.
	AC power cord unplugged.	Plug in AC power cord.
	AC input circuit breaker tripped.	Reset AC circuit breaker.
	Battery breaker tripped or fuse open.	Reset battery breaker or replace fuse.
	In-line fuse open (BCK-F)	Replace fuse.
	Battery cable disconnected.	Connect battery cable.
	Battery voltage below Low Voltage Cutout threshold from extended power outage. Batteries have been disconnected by logic card to prevent over-discharging.	If alternative power is available, plug module in and allow it to recharge the batteries.
	Marginal battery capacity or faulty batteries.	Check batteries and replace if necessary.

SYMPTOM	PROBABLE CAUSE	REMEDY
No output to cable; AC line power available; Green “LINE ON” indicator ON; Red “STANDBY” indicator OFF.	AC output fuse open.	Replace fuse.
	SPI "ALT/ON" switch in wrong position.	Move switch to ON position.
	Loose seizure screw inside SPI.	Tighten screw.
	SPI not connected to module's terminal strip.	Check connection at pins 3 and 4 on module's side panel.

SYMPTOM	PROBABLE CAUSE	REMEDY
No output to cable; No AC line power; Green “LINE ON” indicator OFF; Red “STANDBY” indicator ON.	AC output fuse open.	Replace output fuse.
	SPI "ALT/ON" switch in wrong position.	Move switch to the "ON" position.
	Loose seizure screw inside SPI.	Tighten screw.
	SPI not connected to module's terminal strip.	Check connection at pins 3 and 4 on module's side panel.

SYMPTOM	PROBABLE CAUSE	REMEDY
Incorrect output voltage.	Wrong type of voltmeter used.	Use true RMS meter.
	Under-loaded output (less than 1 Amp).	Connect load.
	Over-loaded output.	Reduce load.
	Faulty resonant capacitor (will appear swollen or distorted; may leak oil).	Replace capacitor.

9.4 TROUBLE-SHOOTING GUIDE, *continued*

SYMPTOM	PROBABLE CAUSE	REMEDY
Low output voltage when unit is in STANDBY mode.	Defective inverter transistors.	Replace power board assembly.

SYMPTOM	PROBABLE CAUSE	REMEDY
No output voltage when attempting to transfer from AC LINE to STANDBY mode - “clicking” sound from contactor.	Battery breaker OFF.	Switch battery breaker ON.
	Battery voltage below recharge acceptance level.	Check battery voltages; check terminal connections; charge or replace battery(s) if necessary.
	High resistance at battery connection.	Check battery open circuit voltages; clean and tighten each connection; replace faulty battery.
	Logic card incorrectly seated in card-edge connector.	Remove, clean and reseat assembly.
	Faulty logic.	Replace logic card.
	Inverter transistors damaged.	Replace power board.
	Faulty contactor.	Replace contactor.

SYMPTOM	PROBABLE CAUSE	REMEDY
Power module does not transfer from STANDBY to AC LINE mode when input power is restored; contactor “clicks” periodically.	Low AC line voltage.	Use voltmeter to verify 120 VAC at receptacle.
	High impedance AC line.	Check all connections. Check for correct wire gauges; Shorten cables to AC utility.
	Faulty logic.	Replace logic card.

SYMPTOM	PROBABLE CAUSE	REMEDY
Batteries will not charge.	Battery breaker OFF, or battery fuse open.	Switch battery breaker ON, or replace battery fuse.
	Faulty batteries.	Check open circuit voltage; Check voltage under load; Check terminals and connecting wires. Replace faulty battery(s).
	Charger fuse open. (on power board)	Replace 10 Amp fuse.
	Faulty charger circuit.	Replace logic card.
	Charger transistors damaged.	Replace power board.

9.4 TROUBLE-SHOOTING GUIDE, *continued*

SYMPTOM	PROBABLE CAUSE	REMEDY
Incorrect or, no float or equalize charge voltages.	Battery breaker OFF, or battery fuse open.	Switch battery breaker ON, or replace battery fuse.
	SCB charge voltages out of calibration.	Replace logic card. (See section 6.8).
	APM charge voltages incorrectly set.	Adjust switch settings. (See section 6.8).
	Charger fuse open (on main power board).	Replace 10 Amp fuse.
	Faulty logic.	Replace logic card.
	Charger transistors damaged.	Replace power board.

SYMPTOM	PROBABLE CAUSE	REMEDY
Battery breaker trips when attempting to transfer from AC LINE to STANDBY mode.	Inverter transistors damaged.	Replace power board.
	Faulty logic.	Replace logic card.

SYMPTOM	PROBABLE CAUSE	REMEDY
Open 10 Amp charger fuse on power board.	Faulty fuse.	Replace fuse.
	Faulty charger.	Replace power board.
	Defective charger transistors.	Replace power board.

SYMPTOM	PROBABLE CAUSE	REMEDY
MOV inside SPI darkened or destroyed.	Lightning or other transient damage on the output.	Replace MOV in SPI.

WARRANTY.

Alpha Technologies, Inc., provides a LIMITED WARRANTY covering the performance of its Broadband products. The terms and conditions of the LIMITED WARRANTY STATEMENT are contained in a separate written LIMITED WARRANTY STATEMENT included with the Operator's manual provided with this product. If there are any warranty claims, the purchaser (or purchaser's representative) must follow the LIMITED WARRANTY guidelines, described in the applicable LIMITED WARRANTY STATEMENT.

[Power]

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